Agricultural Economic Report No. 257

UNITED STATES AND WORLD FERTILIZER OUTLOOK 1974 AND 1980

Economic Research Service
U.S. Department of Agriculture

PREFACE

This staff report was prepared at the request of Senator Hubert H. Humphrey, Chairman, Subcommittee on Agricultural Policy, for the Subcommittee on Agricultural Credit and Rural Electrification and the Subcommittee on Foreign Agricultural Policy of the Committee on Agriculture and Forestry, United States Senate. It is reprinted from a Congressional Committee Print.

The report addresses primary questions concerning the fertilizer situation. How tight is the current supply and demand balance? Where might shortages occur? What will be their impact? Is the current situation indicative of even larger shortages in the future? What barriers loom, and how can they be overcome? What policy measures are needed to correct the situation?

Attention is directed to the situation and outlook in the United States and the world with emphasis on less developed countries. Because of inadequate data, the situation in individual States or localities within the United States could not be explicitly addressed. It should not be inferred, however, that the situation in these areas parallels that for the United States. Conditions vary considerably, and the severity of the problem in some areas greatly exceeds that for the United States in general.

The report activity was coordinated by David M. Bell, National Economic Analysis Division, ERS. Important contributions were made by John H. Berry, Donald D. Durost, John F. Gale, David N. Harrington, and Leroy C. Quance of the National Economic Analysis Division; Richard B. Reidinger and Anthony Rojko, Foreign Demand and Competition Division; David Culver and Wyatte Harman, Commodity Economics Division, all of ERS, and John N. Mahan, Agricultural Stabilization and Conservation Service.

Washington, D.C. 20250 May 1974

TABLE OF CONTENTS

TABLE OF CONTENTS, Continued

SUMMARY

Shortages and high prices of nitrogen and phosphate fertilizers can be expected in the United States throughout 1974. Nitrogen supply may fall short of the quantity demanded by as much as 5 percent, while phosphate may be short by as much as 15 percent. The increase in the supply of potash will be sufficient to meet the expected 7-percent increase in the quantity demanded.

Nitrogen and phosphate shortages result primarily from substantial increases in demand in both domestic and foreign markets. Crop prices are higher than they have been for a number of years and U.S. farmers are responding with a larger planted acreage of fall wheat and intentions of planting larger acreages of corn, cotton, sorghum, spring wheat, and other crops. These higher crop prices and the record high level of net farm income in 1973 are expected to cause the demand for nitrogen fertilizers to reach 9.3 million tons for the year July 1, 1973, to June 30, 1974, a 12-percent increase over 1973 consumption. The quantity of phosphate demanded is expected to increase 9 percent, reaching 5.5 million tons. The projected demand for fertilizer would be even higher were it not for the high fertilizer prices.

Net exports affect the domestic availability of nitrogen and phosphate fertilizers. It appears that net exports of nitrogen in 1974 will be slightly lower than last year. For the July 1, 1973, to June 30, 1974, period, net exports of nitrogen are estimated at about 444,000 tons. On the other hand, it appears net exports of phosphate may increase as much as 203,000 tons over

a year earlier and reach about 1.3 million tons. Exports would have been greater had it not been for the decontrol of domestic fertilizer prices and the commitment to the Cost of Living Council by fertilizer producers to divert fertilizer sales from foreign markets into the domestic market.

With nitrogen production straining at plant capacity, and net exports down slightly, net domestic supply will increase about 8 percent, hardly sufficient to cover the 12-percent increase in demand. Phosphate production is expected to increase only 2 percent, and with net exports up, domestic supply available for consumption is not expected to exceed last year's supply--it may even be less.

The supply-demand situation for nitrogen and phosphate, and the higher costs of producing and transporting all fertilizer materials will keep upward pressure on fertilizer prices through 1974.

Data from 14 States indicate that shipments of fertilizer in July through November 1973 were up substantially in each of those States over the same period a year earlier. Nevertheless, farmers and retailers are reporting shortages. Apparently, some distributors and farmers are getting more fertilizer than they received last year at this time largely at the expense of those reporting shortages. Thus, the channels for distributing fertilizer to farmers appear to have changed from earlier years when there was a surplus of fertilizer.

Substantial increases in crop production over 1973 can still be expected for several reasons. Acreages of most crops will be greater, with total harvested acres expected to rise 5 percent. Weather conditions so far have been very favorable--a sharp contrast to the 1972/73 crop year. Third, nitrogen use will be up. A deficit of 450,000 tons implies that instead of increasing nitrogen use to 9.3 million tons, it will climb only about 8.8 million tons. This is an increase of about 6 percent over 1973 use and should be sufficient for increased crop production. Although application rates of nitrogen may be cut back as great as 5 percent from the levels planned, application rates for many crops will still be higher than in 1973. This reduction in planned application rates should have a negligible impact on yield.

The expected phosphate deficit is substantial. Nevertheless, phosphate application rates have been high in order to build up the phosphate content of the soil. In any given year, the phosphate used by crops is frequently a small portion of that applied. Consequently, a 15-percent reduction in application rate is not expected to adversely affect yields greatly.

Farmers in foreign countries are also attempting to bolster agricultural production following widespread drought in 1972 and high crop prices in 1973. The world demand for nitrogen is expected to increase to 45 million tons, an increase of 11 percent over 1973. Phosphate consumption is expected to increase 7 percent to 28 million tons, and potash consumption 5 percent, to just over 21 million tons. Fertilizer manufacturers in Less Developed Countries have been unable to fully utilize their nitrogen and phosphate plants because of unavailability of raw materials, electric power fluctuations and shortages, labor problems, faulty equipment, and a host of other problems. Consequently, they depend on imports for about a third of their nitrogen and phosphate supplies.

The world fertilizer situation in 1974 parallels the U.S. situation. The demand for nitrogen about equals supply. Supply greatly exceeds expected domestic demand only in West Europe and Japan. In the developing regions of the world, about a third of their nitrogen will have to be supplied with imports. A similar situation exists for phosphates. The major difference is that North America, Developing Africa, East Europe, and the USSR are the countries where production significantly exceeds domestic USSR demand. This is one of the reasons for the increased net exports of phosphates from the United States.

Less Developed Countries may be severely impacted by high prices and shortages. Wheat and rice varieties that characterize the Green Revolution produce no more than traditional varieties unless fertilized and irrigated. High fertilizer prices and limited foreign exchange leave LDC's vulnerable.

World and U.S. phosphate production will increase considerably in 2 to 3 years as new plants currently being built come onstream. But a minimum of 3 years is required to build new plants, and with the few that are currently under construction, the tight nitrogen situation will prevail until at least 1977-78. If nitrogen producers to not increase production capacity beyond intentions, supplies will not be adequate in 1980.

Natural gas shortages in the United States will limit expansion of domestic nitrogen production capacity. Unless long-term natural gas contracts can be obtained or economical substitutes for natural gas can be developed, the United States may once again need to become a nitrogen importer, probably from neighboring countries.

Worldwide, adequate natural gas reserves are available for producing nitrogen. Reserves of phosphate and potash are also sufficient. But reserves of each of these products tend to be concentrated in specific regions. This will necessitate substantial international trade if the most efficient use of world fertilizer supplies is realized.

UNITED STATES AND WORLD FERTILIZER OUTLOOK, 1974 and 1980

INTRODUCTION

The benefits of improving soil fertility have been recognized for centuries, and man has identified and developed numerous methods for releasing and supplementing the growth potential of soil. However, greatest progress has been achieved since the development of chemical fertilizers.

Between 1940 and 1970, consumption of nitrogen (N) increased more than 17-fold in the United States, while consumption of phosphates (P_2O_5) rose 5-fold, and potash (K_2O) 9-fold. Between 1960 and 1970, world plant nutrient consumption paralleled that of the United States. Consumption of N about tripled and consumption of both P_2O_5 and K_2O approximately doubled.

The structure of the world fertilizer industry has changed also. Prior to World War II, only seven firms were manufacturing anhydrous ammonia in the United States. The two largest firms accounted for 87 percent of production. By 1969, there were more than 85 firms producing anhydrous ammonia. But the four largest firms accounted for less than 18 percent of production.

This rapid expansion in firm numbers resulted primarily from technological changes and expanding market prospects. Introduction of centrifugal compressors for producing nitrogen in the late fifties reduced the cost of production. This stimulated a rush to build new plants through the sixties. But more importantly, the demand for nitrogen was very strong. Most producers believed that the phenomenal increase in U.S. nitrogen consumption would continue in order to produce food to meet domestic requirements and to enable shipments of large quantities of grains to Less Developed Countries (LDC's). Furthermore, fertilizer producers in developed nations felt that the Green Revolution in the LDC's would always provide a lucrative export market for their product.

In the mid to late sixties, however, the anticipated rise in world fertilizer consumption faltered and many developing countries expanded their own fertilizer production capacity. By 1968, the capability of the U.S. fertilizer industry to produce and distribute its products far exceeded actual consumption.

Fertilizer prices plummeted. By 1970, the retail price of anhydrous ammonia fell to one-half its earlier level and phosphate and potash prices decreased about 12 percent. Plans to add further capacity were dropped and in some cases construction was halted. Numerous older plants were closed and ownership of other plants changed rapidly. Thus, as the industry tried to recover, virtually all expansion in domestic production capacity ceased.

Through the efforts of numerous development organizations and the governments in developing countries, growth continued in the use of fertilizers in LDC's. Localized droughts in several parts of the world in 1971 and a major widespread drought in 1972 also stimulated many countries to begin importing fertilizer at record levels as they tried to rebuild agricultural production. Moreover, production abilities of the developed nations were challenged as they tried to expand food and fiber production to satisfy their domestic requirements and to supply food to the stricken countries. Consequently, world fertilizer supply and demand moved back into balance much faster than had been anticipated.

The harsh lesson fertilizer producers learned in the sixties made them understandably cautious about rapidly expanding capacity in the seventies. Short natural gas supplies and environmental problems also frustrated their expansion efforts. Although expansion is now underway, a lead time of 2 to 4 years is required to get new plants onstream.

This report will attempt to address some of the questions concerning the fertilizer situation. How tight is the current supply and demand balance? Where might shortages occur? What will be their impact? Is the current situation indicative of even larger shortages in the future? What barriers loom, and how can they be overcome? What policy measures are needed to correct the situation?

UNITED STATES FERTILIZER SITUATION: 1974

Fertilizer Consumption

Fertilizer product use in the United States was a record 42.5 million tons of materials in the year ended June 30, 1973--up from 41.2 million tons the year before (table 1). This increase resulted primarily from increased crop acreage in 1973.

Plant nutrient use continued to grow in 1972/73. Nitrogen and phosphate use were each up more than 4 percent, while potash use increased about 2 percent.

Table 1--Total fertilizer material use and primary nutrient use, United States, 1960-73 1/

Year ending June 30	Total use	Primary nutrient use				
		N	Available P_2O_5	K_2O	Total	Index
	1,000 tons	*1,000 tons*	*1,000 tons*	*1,000 tons*	*1,000 tons*	*1967=100*
1960	24,887	2,738.0	2,572.4	2,153.3	7,463.7	53.4
1961	25,567	3,030.8	2,645.1	2,168.5	7,844.4	56.1
1962	26,615	3,370.0	2,807.0	2,270.5	8,447.5	60.5
1963	28,844	3,929.1	3,072.9	2,503.4	9,505.4	68.0
1964	30,681	4,352.8	3,377.8	2,729.7	10,460.3	74.9
1965	31,836	4,638.5	3,512.2	2,834.5	10,985.3	78.6
1966	34,532	5,326.3	3,897.1	3,221.2	12,444.7	89.1
1967	37,082	6,027.1	4,304.1	3,641.8	13,973.6	100.0
1968	38,743	6,787.6	4,453.3	3,792.6	15,033.5	107.6
1969	38,949	6,957.6	4,665.6	3,891.6	15,514.8	111.0
1970	39.591	7,459.2	4,573.9	4,035.7	16,068.8	115.0
1971	41,118	8,133.6	4,803.4	4,231.4	17,168.4	122.9
1972[2]	41,206	8,016.0	4,873.1	4,332.0	17,221.1	123.2
1973[3]	42,536	8,338.8	5,072.0	4,411.5	17,822.3	127.5

[1] Includes Puerto Rico. [2] Revised. [3] Preliminary.

Source: Years 1960-69 from "Consumption of Commercial Fertilizers and Primary Plant Nutrients", Stat. Bull. 472, Statis. Rptg. Serv., June 1971. Years 1970-73 from "Consumption of Commercial Fertilizers in the United States" SpCr 7 (10-73) Statis. Rptg. Serv., U.S. Dept. Agr., November 1973 and earlier issues.

Potential consumption of nitrogen fertilizer in 1974 is estimated to increase 12 percent to 9.3 million tons or about 1 million more than was used in 1973. Most of the increased demand is for corn, wheat, cotton, and soybean production (table 2). The desired plant nutrient application rates used per acre for these crops are expected to about equal the 1972 rates--slightly more than in 1973. In the aggregate for all crop acres, the nitrogen use per acre would increase only half a pound above the 1972 level and just over 3 pounds above 1973.

Table 2--Acres of crops harvested, fertilizer application rates, and fertilizer consumption, United States, 1972-74

Crops	1972			1973			1974		
	Acreage harvested	Application rate	Consumption	Acreage harvested	Application rate	Consumption	Acreage harvested	Application rate	Consumption
	Million acres	Pounds per acre	1,000 tons	Million acres	Pounds per acre	1,000 tons	Million acres	Pounds per acre	1,000 tons
					Nitrogen				
Corn	57.4	110.4	3,170	61.8	106.0	3,274	68.8	110.0	3,780
Wheat	47.3	28.5	674	53.9	30.2	815	64.0	32.0	1,030
Cotton	13.0	57.8	375	12.0	54.0	324	13.5	55.0	370
Soybean	45.7	3.1	70	56.4	3.4	95	54.4	3.0	80
Total specified crops	163.4		4,289	184.1		4,508	200.7		5,260
Other crops	130.0		3,727 2/	137.5		3,831 2/	138.3		4,040 2/
Total	293.4	54.6	8,016	321.6	51.8	8,339	339.0	54.9	9,300
					Phosphate				
Corn	57.4	59.4	1,705	61.8	55.0	1,700	68.8	59.0	2,030
Wheat	47.3	16.3	385	53.9	17.1	461	64.0	17.0	540
Cotton	13.0	30.3	197	12.0	29.2	175	13.5	30.0	200
Soybeans	45.7	12.2	279	56.4	13.4	378	54.4	13.0	350
Total specified crops	163.4		2,566	184.1		2,714	200.7		3,120
Other crops	130.0		2,307 2/	137.5		2,358 2/	138.3		2,380 2/
Total	293.4	33.2	4,873	321.6	31.5	5,072	339.0	32.4	5,500
					Potash				
Corn	57.4	59.3	1,702	61.8	56.8	1,755	68.8	59.0	2,030
Wheat	47.3	5.7	135	53.9	6.1	164	64.0	6.0	190
Cotton	13.0	25.0	163	12.0	24.2	145	13.5	25.0	170
Soybeans	45.7	15.8	361	56.4	17.6	496	54.4	18.0	490
Total specified crops	163.4		2,361	184.1		2,560	200.7		2,880
Other crops	130.0		1,971 2/	137.5		1,852 2/	138.3		1,820 2/
Total all harvested crops	293.4	29.6	4,332	321.6	27.4	4,412	339.0	27.7	4,700

1/ Estimate based on Winter Wheat Report, Crop Production CrPr (12-73), Dec. 21, 1973, and Prospective Plantings for 1974 - 35 States, Crop Production CrPr 2-4 Jan. 22, 1974, Crop Reporting Board, Statis. Rptg. Serv. U.S. Dept. Agr.
2/ Includes an allowance for use on nonharvested crops and nonfarm use.

Phosphate demand in 1974 is estimated to increase half a million tons or 9 percent, chiefly because of increases in corn and wheat acreages. Desired phosphate application rates per acre for corn are expected to about equal the 1972 rates--somewhat higher than was used in 1973. Planned wheat, cotton, and soybean application rates are estimated to continue at near the 1973 levels.

Potash application rates per acre have remained constant in recent years for most crops. Acreage changes tend to be the most important factor determining consumption. The average rate estimated for all crops in 1974 is near the average for the last 2 years. Total potash consumption is estimated to increase 7 percent, or about 300,000 tons more than in 1973.

The quantity of fertilizer farmers are expected to demand in 1974 is chiefly the product of crop acreages planted and factors affecting fertilizer application rates. Based on planting intentions expressed in January, farmers will harvest about 339 million acres in 1974 (table 2). This represents an increase of 17 million acres, or 5 percent above the 1973 level. It is 46 million acres more than were harvested in 1972. Most of the 1974 acreage increase is expected in corn, wheat, and cotton. Soybean acreage may decline slightly.

In planning fertilizer application rates, farmers need to consider the price of fertilizer, the prices of other factors of production, expected crop prices, the yield response associated with various levels of fertilizer use and the availability of operating capital.

Since October 25, 1973, when fertilizer prices were exempted from ceilings, prices have risen rapidly. By mid-January, nitrogen prices had increased 60 to 70 percent compared with October prices; phosphate prices increased more than 40 percent; and potash prices rose nearly 30 percent. Under normal market conditions, higher fertilizer prices would tend to reduce application rates. However in 1974, crop prices are expected to be high--surpassed only by 1973 prices.

Given current crop yield response to fertilizer application, farmers are expected to continue the use of fertilizer, at least up to recent rates if it is available. And farmers should have little trouble financing increased fertilizer expenditures because net farm income was at a record high level last year.

Weather conditions occasionally limit the execution of planned operations. The fall of 1972 and spring of 1973 is an example. A wet fall throughout much of the country prevented farmers from completing their normal fall plowing and fertilization. This became even more serious when the spring of 1973 also proved to be exceedingly wet. Consequently, many crops were planted later than normal; there were some adjustments in the acres of crops planted; and fertilization plans had to be altered.

The fall of 1973 contrasted sharply with 1972. Warm and dry weather fostered a speedy harvest and more-than-normal fall plowing and fertilization.

With a normal spring in 1974, fertilization problems encountered the previous year should be reduced. Consequently, fertilizer application rates for 1974 are expected to be somewhat above 1973 levels.

Fertilizer Production

In the United States, nitrogen is produced by approximately 60 firms operating about 90 plants with an engineered annual capacity of 17 million tons of anhydrous ammonia--the basic nitrogen fertilizer. With high nitrogen prices, producers are straining the effective capacities of their facilities by operating at about 94 percent of capacity. Curtailment of natural gas supply has not appeared to be a major constraint on production so far this year. Of the 13.15 million tons of nitrogen in the 16 million tons of ammonia produced, one-fourth is used in other industries, leaving 9.86 million tons available for fertilizer uses. Including other nitrogen sources, domestic production is expected to be 10.2 million tons in 1974, up from the 9.6 million tons in 1973.

Phosphate is produced by about 25 companies in about 30 plants. The estimated capacity of these plants is about 6.5 million tons P_2O_5. Production from these plants is expected to reach 5.9 million tons. Other phosphate sources will bring the domestic production to 6.5 million tons, up slightly from the 6.4 million tons in 1973.

Potash is produced by 11 companies located in the southwest, primarily New Mexico. Capacity of their plants is 2.9 million tons. Production in 1974 is expected to reach 2.5 million tons. With other sources of potash, domestic production is expected to reach 2.93 million tons in 1974, up from the 2.68 million tons in 1973.

U.S. Foreign Trade

When the U.S. fertilizer industry overexpanded in the mid-sixties, it turned to the export market to help recover from chronic surpluses. Until that time, the United States had always been a net importer of nitrogen. But in 1966, exports exceeded imports and continued to climb steadily until 1969 when they peaked at 1.59 million tons (fig. 1). Exports then declined until 1973. They again rose last year and are expected to rise slightly to 1.39 million tons in 1974. This quantity is 14 percent of domestic production. During the past 4 years, nitrogen imports have remained relatively stable. In 1974, they are expected to rise to 946,000 tons. Thus, net nitrogen exports in 1974 are expected to be 444,000 tons--down somewhat from the 469,000 tons in 1973.

The United States is one of the major phosphate exporters in the world, accounting for over 30 percent of world exports in 1972. Except for 1969 and 1970, exports increased each year over the previous year's level (fig. 2). In 1974 exports are expected to reach 1.6 million tons, 25 percent of domestic production and 13 percent more than 1973 exports. Since imports will decline to 291,000 tons, net exports are expected to be 1.3 million tons--up 18 percent from the 1.1 million tons in 1973.

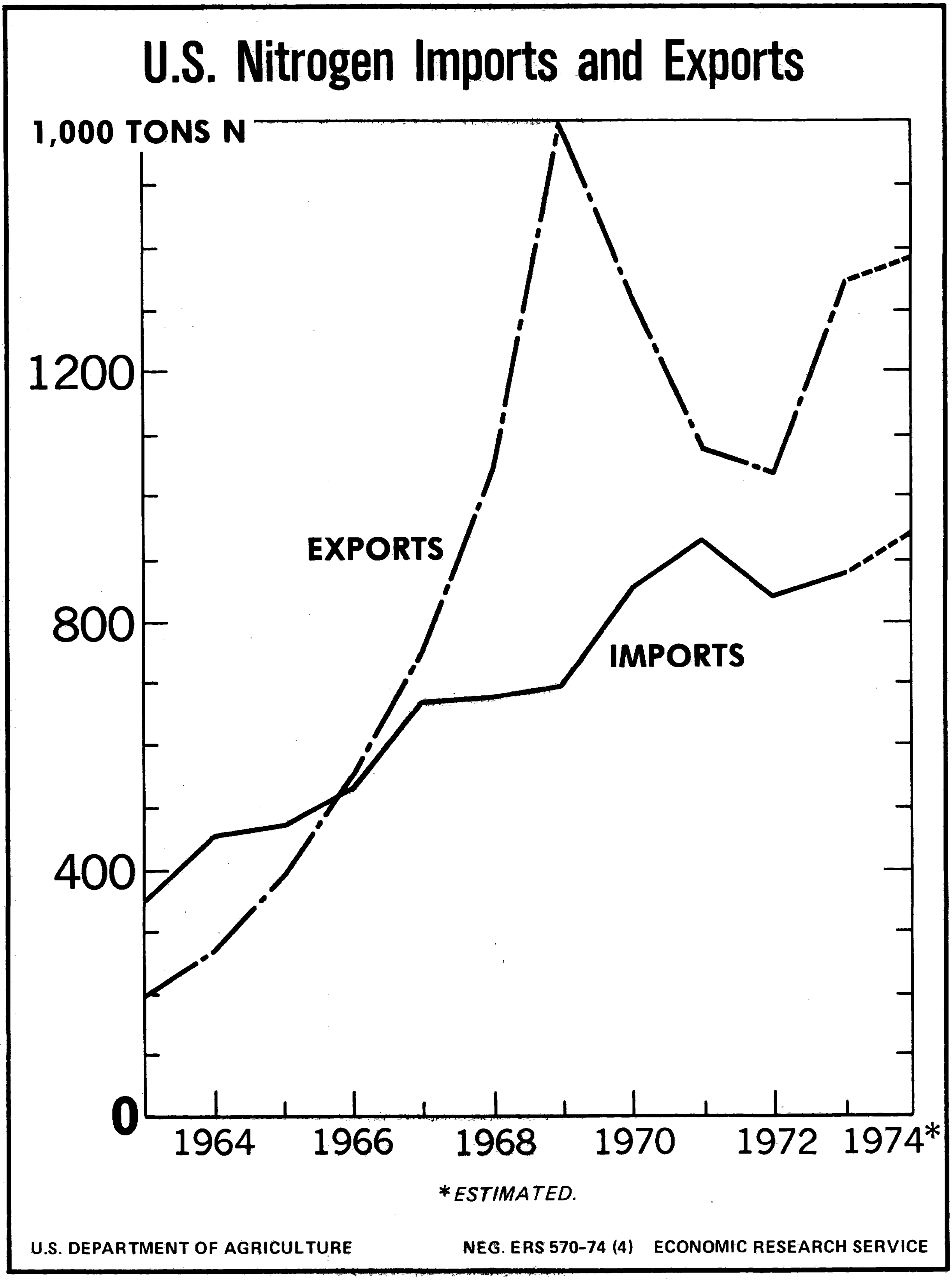

U.S. Nitrogen Imports and Exports
1,000 TONS N
1200
800
400
0
EXPORTS
IMPORTS
1964
1966
1968
1970
1972
1974*
*ESTIMATED.
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 570-74 (4)
ECONOMIC RESEARCH SERVICE

Figure 1

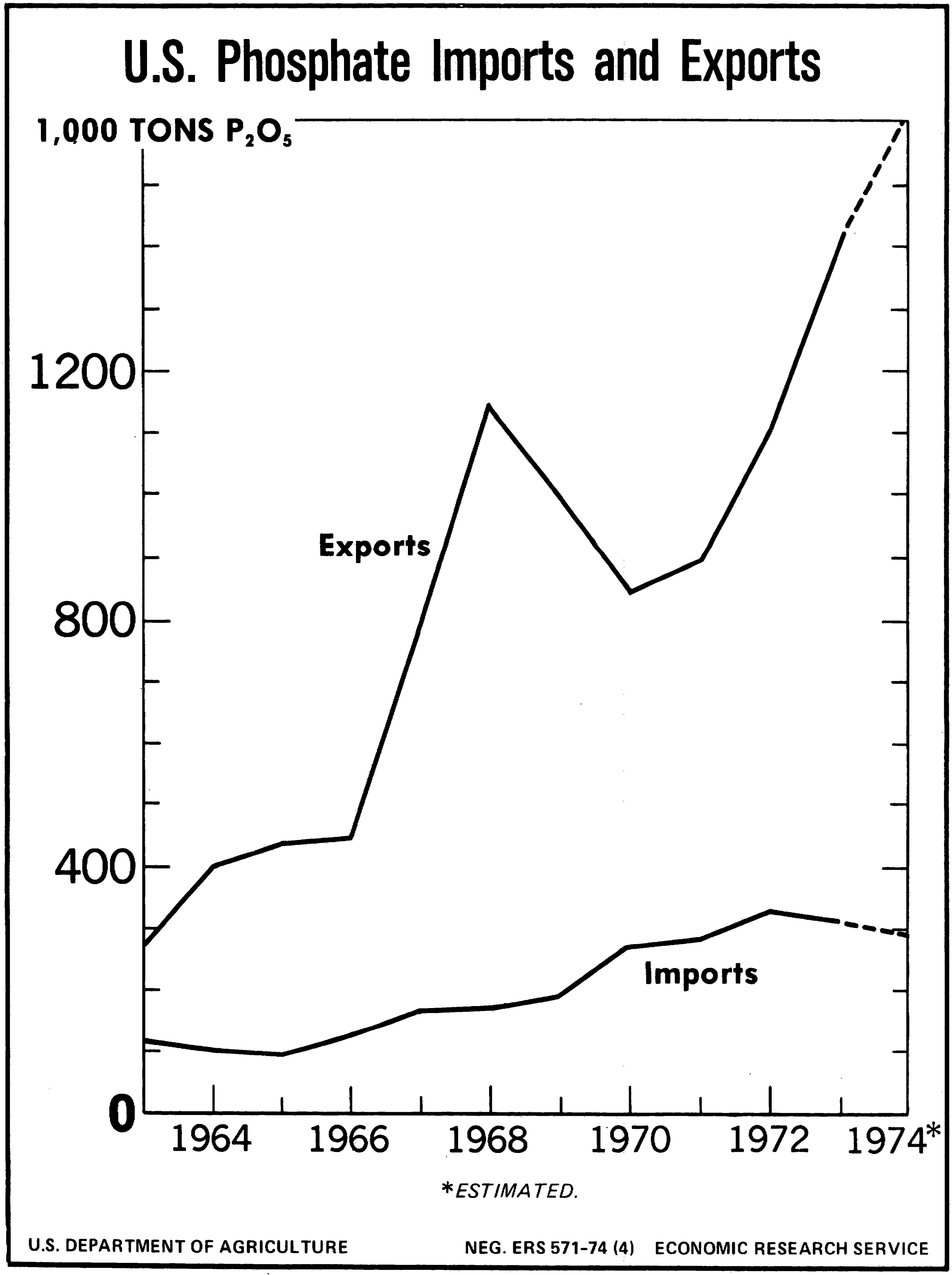

U.S. Phosphate Imports and Exports
1,000 TONS P_2O_5
1200
800
400
0
Exports
Imports
1964
1966
1968
1970
1972
1974*
*ESTIMATED.
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 571-74 (4)
ECONOMIC RESEARCH SERVICE

Figure 2

Increased nitrogen and phosphate exports result from sharply higher world prices, especially when compared with domestic prices. During years of fertilizer surplus in the mid to late 1960's, world prices were below domestic prices. Thus, only surplus quantities of U.S. fertilizers were exported. However with the tightened world fertilizer situation, rising prices made the export market economically attractive. To counteract this stimulus to export more fertilizers, the Cost of Living Council, on October 25, 1973, decontrolled fertilizer prices. This enabled U.S. farmers to be more competitive for fertilizer via higher prices. Yet, world prices have continued to increase and the economic incentive to export remains strong.

Only a small portion of the potash consumed in the United States is domestically produced. The cost of mining potash in the New Mexico area allows it to compete with potash from more efficient Canadian sources only in those areas where there is a substantial transportation cost advantage. Consequently, Canada supplies over one-half of the potash consumed in the United States. In 1974, approximately 4 million tons of potash will be imported from Canada--up from just over 3 million tons in 1973 (fig. 3). With exports of 1 million tons, net imports will be 3 million tons, or 0.7 million more tons than in 1973.

Fertilizer Nutrient Balance

Although domestic supplies of potash are more than adequate to meet demand, nitrogen and phosphate supplies are short of the quantities demanded (table 3). The increase in production is simply not sufficient to satisfy the expected increase in demand. The nitrogen deficit is estimated at 150,000 to 450,000 tons, or from 1.5 to 5 percent of demand. The phosphate deficit is more severe than the nitrogen deficit, ranging from 12 to 15 percent of demand.

These deficits may not be evenly distributed. A substantial number of spot shortages have been reported by retailers and farmers, in spite of increased fertilizer shipments. Although we do not have information from all States, data from 12 States across the southern United States and from Missouri and Ohio show 47 percent more nitrogen, phosphates, and potash was shipped into these States during the July through November, 1973, period than the same period a year earlier.

Nitrogen accounted for a major percentage of these increased shipments. By States, Louisiana and Oklahoma had received about 85 percent as much nitrogen during the 5-month period as they consumed during the previous 12 months. Four States had received 50 to 70 percent of their previous year's consumption. The remaining 8 States had received less than 50 percent of their previous year's consumption. However, in all States, the shipments for the 5-month period exceeded shipments in the corresponding period a year earlier.

Thus, with reported shortages in spite of increased shipments, some retailers, farmers, or others must be getting more fertilizer than they received last year at this time. The flow of fertilizer through distribution channels from manufacturer to dealer to farmer apparently has changed from earlier years during fertilizer surpluses.

Unless more fertilizer enters the traditional channels, some farmers may not obtain the fertilizer they want. Without adequate fertilizer, their crop production and income will likely be reduced.

Several factors may explain the shifting distribution patterns. First, a number of fertilizer dealers and farmers are "shoppers." A "shopper" will pursue numerous alternative sources of fertilizer to get the best buy. In the past, this was usually from a seller who had a surplus and was willing to lower his price to move the product. However without surpluses, "shoppers" have lost their sources and suppliers may be reluctant to release their limited product to a buyer who bypassed them previously. Thus, farmers and distributors who shopped around previously may have a curtailed fertilizer supply in 1974.

Second, suppliers frequently have preferred customers with whom it is more profitable to do business because of their volume, rapid payment, or other economic incentive. In this period of short supply, preferred customers may be fully supplied at the expense of less-preferred customers.

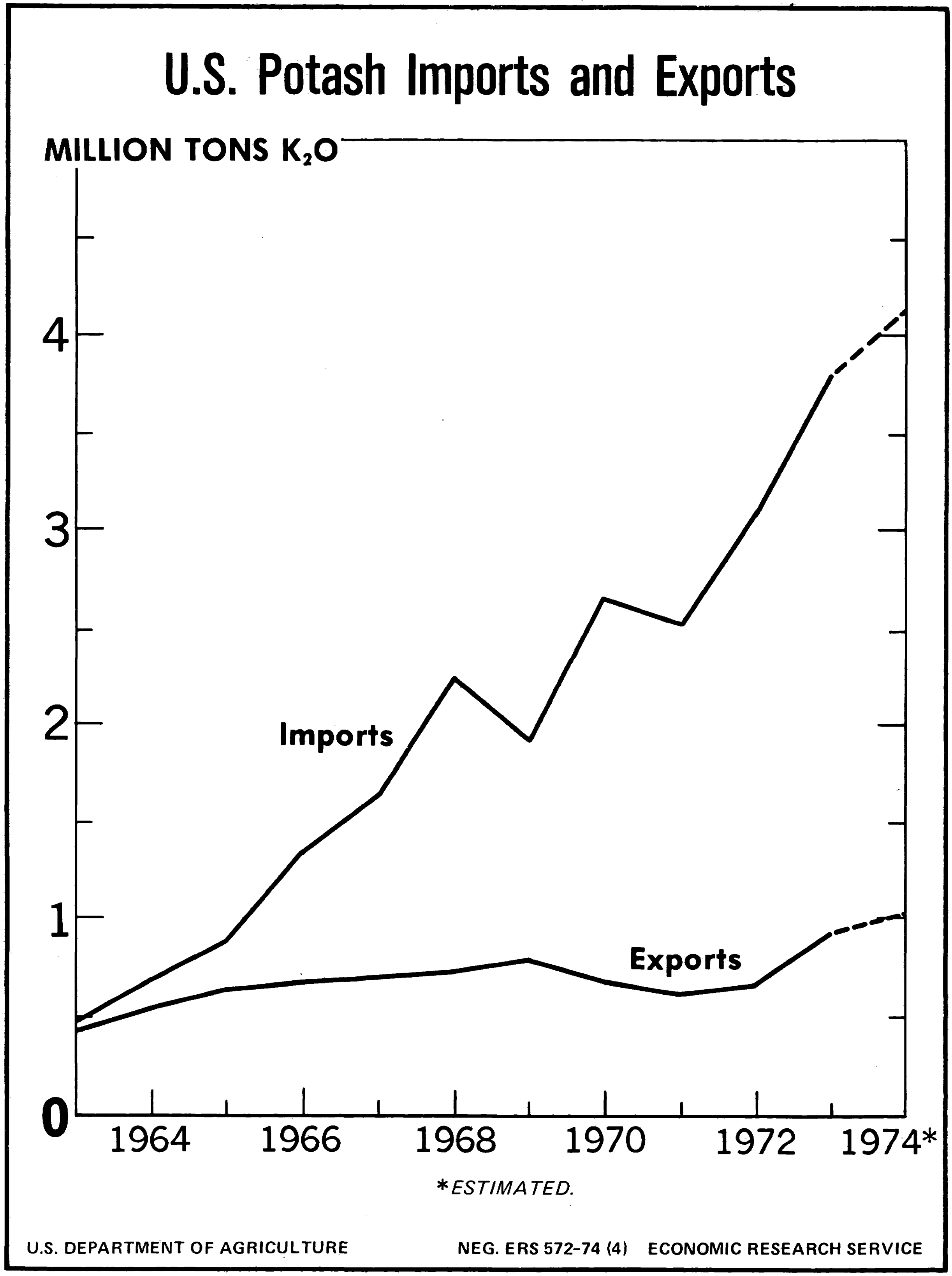
Third, several manufacturers retail part of their production through their own retail distribution system and sell the remainder to independent retailers. However with tight supplies, manufacturers may find it more profitable to market all of their fertilizer through their own retail outlets. This may increase the supply in some localities at the expense of areas served by independents.

Finally, speculators may be holding supplies anticipating substantial price increases. If they have not made commitments to buyers, these stocks virtually disappear in market data until fertilizer begins moving in the spring. Thus, what is currently declared shortage could be partly filled by fertilizer held by speculators.

Impact of Shortages

Assuming that the deficits will amount to 450,000 tons of nitrogen and 836,000 tons of P_2O_5, what will be the impact on crop production?

Substantial increases in crop production over 1973 can still be expected for several reasons. First, total nitrogen use will be up. A deficit of 450,000 tons implies that instead of increasing nitrogen use to 9.3 million tons, it will climb to only about 8.9 million tons. This is an increase of more than 6 percent over 1973 use. Although application rates of nitrogen may be cut back as much as 5 percent from the levels planned, application rates for many crops will still be higher



U.S. Potash Imports and Exports
MILLION TONS K_2O
4
3
2
1
0
Imports
Exports
1964
1966
1968
1970
1972
1974*
*ESTIMATED.
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 572-74 (4)
ECONOMIC RESEARCH SERVICE

Figure 3

Table 3--Fertilizer summary, United States, 1971/72-73/74

Item	1971/72	1972/73	1973/74
	1,000 short tons		
Nitrogen:			
Domestic production 1/	9,097	9,560	10,232
Imports	843	881	946
Total avail. supply	9,940	10,441	11,178
Exports	1,032	1,350	1,390
Net supply	8,908	9,091	9,788
Demand	8,016	8,339	9,300
Unidentified demand 2/	892	752	651-930
Total requirements			9,951-10,230
Deficit			150-450
Phosphate (P_2O_5):			
Domestic production 1/	6,150	6,387	6,529
Imports	326	312	291
Total avail. supply	6,476	6,699	6,820
Exports	1,102	1,424	1,606
Net supply	5,374	5,275	5,214
Demand	4,873	5,072	5,500
Unidentified demand 2/	501	203	385-550
Total requirements			5,885-6,050
Deficit			671-836
Potash (K_2O):			
Domestic production 1/	2,432	2,680	2,929
Imports	3,088	3,192	4,139
Total avail. supply	5,520	5,872	7,068
Exports	657	922	1,013
Net supply	4,863	4,950	6,055
Demand	4,332	4,412	4,700
Unidentified demand 2/	531	538	540
Total requirements			5,240
Surplus			815

1/ Adjusted for producer inventory changes.
2/ Unidentified demand is an amount of material produced and distributed that cannot be accounted for with the current data system. It may include product loss, changes in retail and farm inventories, and other undetermined items.

than in 1973. This reduction from planned application rates should have a negligible impact on yield. At current application levels, the added return from the additional fertilizer is much lower than was expected a few years ago when lower application rates were used. Second, acreages of most crops will be greater. Total harvested acres is expected to rise 5 percent. Third, weather conditions so far have been very favorable, allowing a higher than average application of fertilizer in the fall. The key appears to be weather. Continued favorable weather through the planting and growing seasons should offset the effects of a 5-percent shortfall in available nitrogen.

As in the case of nitrogen, the expected phosphate deficit should have little effect on production. Phosphate application rates have been high during the last few years in order to build up the ambient phosphate content of the soil. In any given year, the phosphate used by crops is frequently a small percentage of that applied. Consequently, a 15-percent reduction in the application of phosphate is not expected to adversely affect yields greatly.

WORLD FERTILIZER SITUATION: 1974 1/

Nitrogen

Since 1960, both production and consumption of nitrogen fertilizers in the world have increased about 300 percent. In 1973, world nitrogen production reached an estimated 42.2 million tons while consumption rose to 40.2 million. Estimates for 1974 indicate that world nitrogen production will climb to 45.8 million tons while consumption will reach 44.8 million tons, increases of 8.5 and 11.4 percent, respectively (table 5).

While each developed region is expected to have a surplus of nitrogen, shortages are expected in the Asian region, including the People's Republic of China (PRC), Taiwan, North Vietnam, North Korea and Monogolia, in the developing regions of Latin America, Developing Africa and Developing Asia. These regions have traditionally been nitrogen importers. West Europe and Japan are major exporters (table 6).

The estimated world nitrogen surplus of about a million tons is only 2 percent of expected consumption and is low by historic standards. With a supply-demand balance this tight, market imperfections, logistical problems and other customary problems and delays may cause some severe shortages.

Expected shortages will impact most heavily on the nitrogen deficit regions as they turn to the world market for supplies. Not only will their supply fall short of expected consumption, but they will face high world prices. Since 1971, prices have increased more than 100 percent (fig. 4)

Countries frequently prefer to import specific products. Although nitrogen is in tight supply, there may be severe shortages of specific products. This will tend to boost the prices of these products beyond what the nitrogen content of the product would justify.

A more serious situation would develop if consumption increased more than expected and production was below the estimated level. The estimated production of fertilizer is based on plants in developed regions operating at 95 percent of capacity and those in LDC's operating at 70 percent of capacity. However, past operating rates have seldom reached these levels. In 1972, capacity utilization was only 92 percent in developed regions and

1/ Estimates in this section are based on current data from the Tennessee Valley Authority, the Foreign Agricultural Service and the Economic Research Service.

66 percent in the developing regions (table 7). While the current price incentive certainly encourages higher operating levels, physical barriers may limit their production to historic levels. Demand could rise above the estimated level if the effort to increase crop production following recent droughts is stronger than anticipated and if high world crop prices induce higher fertilizer application rates. In this situation the deficit would increase in the LDC's, and the world nitrogen surplus could be eliminated.

Phosphate

Production and consumption of phosphate fertilizers have increased by about 150 percent since 1960, considerably less than nitrogen (table 8). It is estimated that in 1973 world phosphate production reached 26.1 million tons P_2O_5 while consumption reached 25.8 million tons--increases over 1972 of 5.3 and 11.1 percent, respectively. Estimates for 1974 indicate that world phosphate production will rise to 28.8 million tons while the quantity demanded will climb to 27.7 million tons--increases of 9.9 percent and 7.4 percent, respectively (table 9).

The estimated world surplus of 1.18 million tons is only 4.3 percent of expected consumption. This is well above the 1-percent surplus estimated for 1973 but still below the average for the past decade. Tight supplies will keep considerable upward pressure on phosphate fertilizer prices. In the case of diammonium phosphate, the price has doubled since 1971 (fig. 2).

The largest deficit regions include Latin America and Developing Asia. Developing Africa has a significant surplus of phosphate fertilizer primarily due to increased production capacity in North African countries. Eastern Europe and the USSR also have increased capacity considerably. These two regions, along with the United States, will account for most of the phosphate exports in 1974.

The above estimates are based on high consumption levels and rather conservative supply estimates. If production increases above the estimate, a substantial phosphate surplus could begin to appear. This should depress world prices.

Potash

In contrast to both nitrogen and phosphate, production of potassium fertilizers has grown significantly faster than consumption since 1960. From 1960 to 1973 production increased 147 percent and consumption increased 125 percent (table 10). World production is expected to reach 23.7 million tons K_2O in 1973 while consumption reached 20.3 million tons. In 1974, production is expected to increase to 24.1 million tons and consumption to 21.4 million tons--increases of 1.6 percent and 5.4 percent, respectively (table 11).

After several years of capacity expansion, prices in the late 60's fell and profits disappeared. By 1970, Canadian potash producers were on the verge of bankruptcy. To protect the industry, the Saskatchewan Govern-

Table 4--World nitrogen fertilizer production and consumption, 1960-73

Year	Production	Consumption
	1,000 short tons	
1960	11,000	10,100
1961	12,000	11,300
1962	13,100	12,100
1963	14,500	13,700
1964	16,400	15,400
1965	18,600	17,000
1966	21,100	19,200
1967	24,700	24,000
1968	28,200	26,400
1969	31,300	29,300
1970	33,300	31,600
1971	36,300	35,000
1972	38,700	37,200
1973 1/	42,200	40,200

1/ Estimated.
Source: FAO Annual Fertilizer Review, 1963 for years 1960-63, 1964 for 1964, 1965 for 1965, 1966 for 1966, 1972 for 1967-72.

Table 5--Estimated world nitrogen fertilizer production, demand, and balance, by region, 1974

Region	Production	Demand	Balance
		1,000 short tons	
North America	11,100	10,500	600
West Europe	11,500	8,200	3,300
East Europe & USSR	11,600	11,200	400
Japan	3,800	1,000	2,800
Other developed nations 1/	700	600	100
Developed regions	38,700	31,500	7,200
Latin America	1,400	2,100	-700
Developing Africa	500	1,000	-500
Developing Asia	3,700	5,100	-1,400
Developing regions 2/	5,600	8,200	-2,600
Other Asia 3/	1,500	5,100	-3,500
World	45,800	44,800	1,000

1/ Includes South Africa, Israel, and Oceania.
2/ Excludes Other Asia.
3/ Includes Peoples Republic of China (PRC), Taiwan, North Vietnam, North Korea and Mongolia.

Source: Based on TVA and unpublished USDA estimates.

Table 6--Net nitrogen fertilizer trade balance, by region, 1967-72 1/

Region	1967	1968	1969	1970	1971	1972
			1,000 short tons			
North America	260	570	1,220	920	630	640
West Europe	2,010	1,980	2,280	1,810	1,730	1,470
East Europe & USSR	-100	10	90	240	440	830
Japan	1,030	1,150	980	1,360	1,560	1,400
Other developed nations 2/	-100	-130	-120	-10	0	-120
Developed regions	3,100	3,580	4,450	4,320	4,360	4,220
Latin America	-370	-520	-560	-530	-650	-690
Developing Africa	-320	-420	-430	-440	-430	-600
Developing Asia	-1,330	-1,880	-1,720	-1,620	-1,190	-1,310
Developing regions 3/	-1,920	-2,820	-2,710	-2,590	-2,270	-2,610
Other Asia 4/	-1,210	-810	-1,430	-1,600	-1,900	-1,700

1/ Positive numbers imply net exports, negative numbers imply net imports.
2/ Includes South Africa, Israel, and Oceania.
3/ Excludes Other Asia.
4/ Includes PRC, Taiwan, North Vietnam, North Korea, and Mongolia.

Source: Tennessee Valley Authority, World Fertilizer Market Review and Outlook, Muscle Shoals, Ala., forthcoming.

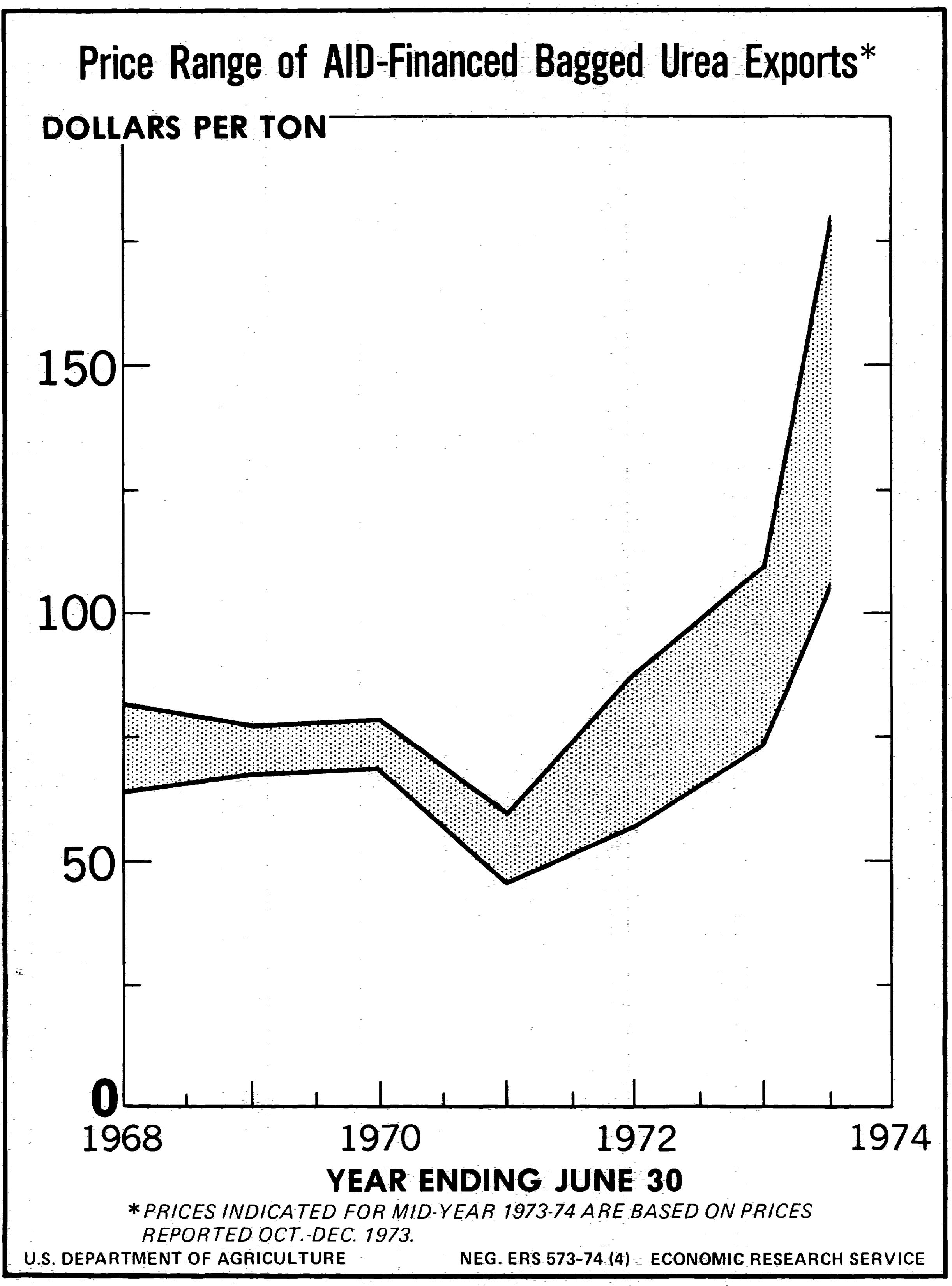

Price Range of AID-Financed Bagged Urea Exports*
DOLLARS PER TON
150
100
50
0
1968
1970
1972
1974
YEAR ENDING JUNE 30
*PRICES INDICATED FOR MID-YEAR 1973-74 ARE BASED ON PRICES REPORTED OCT.-DEC. 1973.
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 573-74 (4)
ECONOMIC RESEARCH SERVICE

Figure 4

Table 7--Effective nitrogen fertilizer production capacity and utilization rate, world, by region, 1972

Region	Effective capacity 1/	Utilization rate 2/
	1,000 short tons	Percent
North America	10,900	92
West Europe	11,400	90
East Europe & USSR	9,700	110
Japan	3,200	72
Other developed nations 2/	600	80
Developed regions	35,800	92
Latin America	1,400	63
Developing Africa	500	23
Developing Asia	3,300	75
Developing regions 4/	5,200	66
Other Asia 5/	2,100	109
World	43,100	90

1/ Tennessee Valley Authority, World Fertilizer Market Review and Outlook, Muscle Shoals, Ala., forthcoming.
2/ Based on production data from FAO, Annual Fertilizer Review, 1972.
3/ Includes South Africa, Israel, and Oceania.
4/ Excludes Other Asia.
5/ Includes PRC, Taiwan, North Vietnam, North Korea, and Mongolia.

ment established production controls and floor prices. As potash consumption increased, capacity utilization rates climbed from less than 50 percent to an estimated 70 percent and profits have reappeared.

Because world potash production is concentrated in only a few locations, several regions show substantial surpluses while others show large deficits. Thus, there is considerable international potash trade. However with a substantial production surplus, prices are not high and few countries find purchasing potash a formidable barrier.

Production Constraints

In addition to plant production capacities, other factors limit the production of fertilizer. In developed countries, availability of raw materials and energy has tended to reduce production levels below potential. The impact has been minimal this year, however, and developed countries are operating near capacity.

LDC's performance is less admirable. In 1972, they were at 66 percent of capacity in nitrogen production, 58 percent in phospate production, and 60 percent of capacity in potash production.

Numerous problems face fertilizer manufacturers in LDC's. Primary are difficulties in obtaining raw materials, electric power fluctuations and shortages, labor problems, faulty equipment (much of which is imported), and a host of miscellaneous problems that arise from an undeveloped infrastructure.

There is no easy solution to these problems. Without support from their individual governments, it is doubtful that much progress can be made. Even in the United States, little progress was made in terms of production and use of fertilizer until the Government established the Tennessee Valley Authority, developed a national fertilizer policy, and heavily subsidized research and extension designed to develop and promote its use.

Impact of Fertilizer Shortages

The impact of the current fertilizer shortage on agricultural production in the other developed countries will likely be no more severe than in the United States. Some LDC's however, may be more severely affected for several reasons. First, fertilizer imports from developed countries account for a major portion of the fertilizer supply in LDC's. Second, world market equilibrium will be reached at high price levels and the adjustments will likely be a slowdown in the rate of growth of consumption. Those countries willing and able to pay the price will get the nitrogen they need. But economically weak countries will have to accept reduced supplies. Third, much of the LDC's progress under the Green Revolution in recent years has been due to the new rice and wheat varieties in combination with irrigation and fertilizer. Without adequate fertilizer supplies, these new varieties do little better than traditional varieties. Thus, the impact is clear. Less fertilizer use means slower growth in agricultural production in some countries that need it dearly.

Reports indicate that of the major LDC's, only India , Pakistan, and Bangladesh have a high likelihood of crop production levels significantly below normal due to fertilizer shortages. High yielding wheat, which requires high fertilizer application rates for high yields, has been the most successful of the Green Revolution crops in India and Pakistan. Much depends on how successful they are in obtaining fertilizer in the next few months. Nevertheless, even with fertilizer shortages, good weather could produce record crops in these countries.

In an effort to minimize the impact of shortages, governments in some LDC's are allocating fertilizer to specific crops. By evaluating their commodity needs and relative world prices, they are attempting to realize maximum benefits from their limited supply of fertilizer.

The importance of increasing fertilizer production levels in the LDC's is evident. By operating nearer capacity, the countries increase their supply of fertilizer and reduce the per unit cost of producing it. They also reduce the need to use limited foreign exchange to purchase fertilizer.

Table 8--Phosphate fertilizer production and consumption, world, 1960-73

Year	Production	Consumption
	1,000 short tons P_2O_5	
1960	10,740	10,580
1961	11,130	10,990
1962	11,440	11,490
1963	12,200	12,190
1964	13,740	13,500
1965	15,260	14,710
1966	16,630	15,860
1967	18,780	17,780
1968	19,870	18,700
1969	20,490	20,060
1970	21,260	20,740
1971	22,970	21,900
1972	24,810	23,250
1973 1/	26,130	25,820

1/ Estimated.
Source: FAO Annual Fertilizer Review, 1963 for years 1960-63, 1964 for 1964, 1965 for 1965, 1966 for 1966, 1972 for 1967-72.

Table 9--Estimated world phosphate fertilizer production, demand, and balance, by region, 1974

Region	Production	Demand	Balance
	1,000 short tons P_2O_5		
North America	7,330	5,900	1,430
West Europe	6,640	6,750	-110
East Europe & USSR	8,010	6,800	1,210
Japan	920	920	0
Other developed nations 1/	1,880	2,020	-140
Developed regions	24,780	22,390	2,390
Latin America	810	1,480	-670
Developing Africa	980	460	520
Developing Asia	900	1,910	-1,010
Developing regions 2/	2,690	3,850	-1,160
Other Asia 3/	1,420	1,470	-50
World	28,890	27,710	1,180

See footnotes and source in table 5.

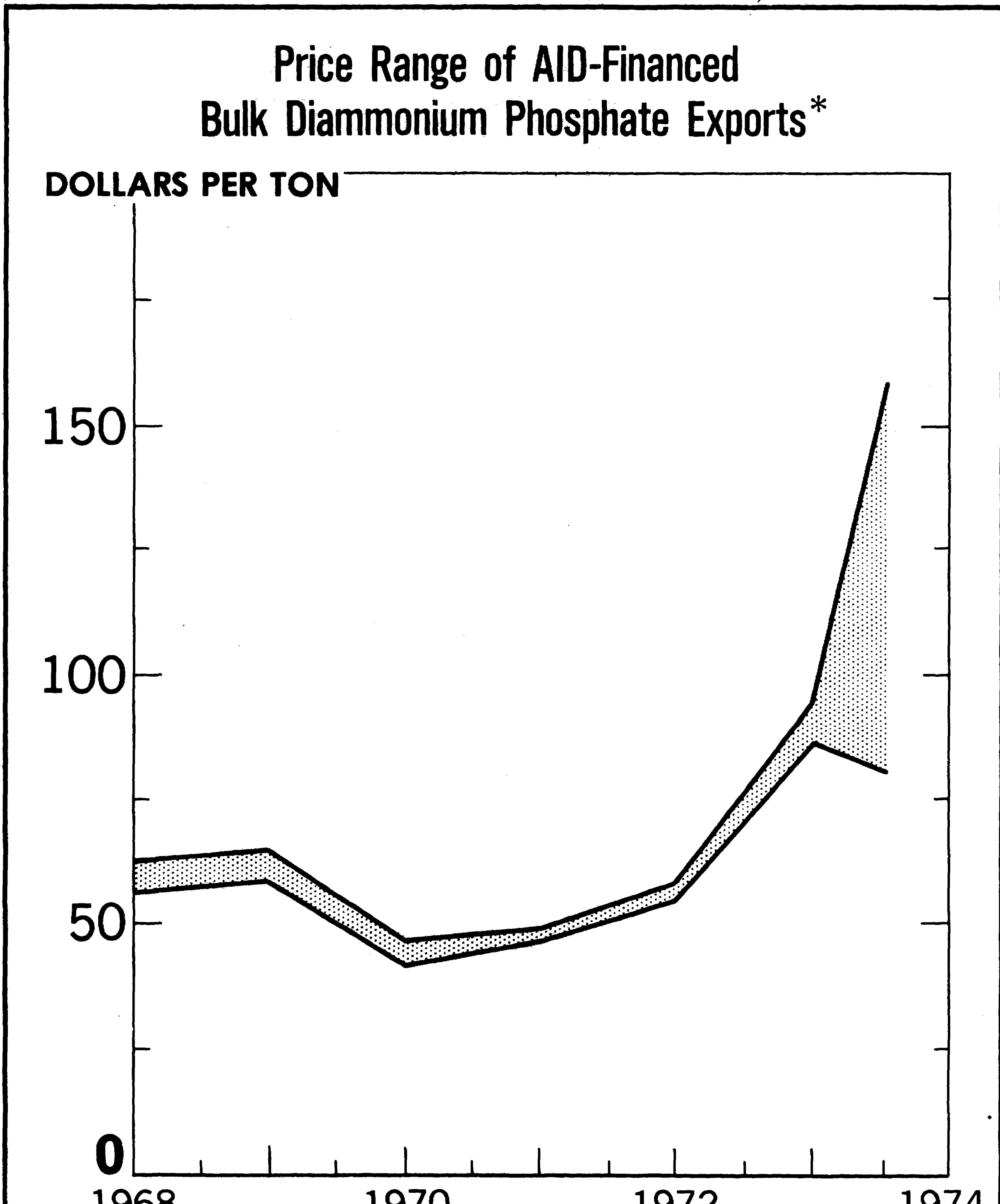

Price Range of AID-Financed
Bulk Diammonium Phosphate Exports*
DOLLARS PER TON
150
100
50
0
1968
1970
1972
1974
YEAR ENDING JUNE 30
* PRICES INDICATED FOR MID-YEAR 1973-74 ARE BASED ON PRICES REPORTED OCT.-DEC. 1973.
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 574-74 (4)
ECONOMIC RESEARCH SERVICE

Figure 5

Table 10--Potash fertilizer production and consumption, world, 1960-73

Year	Production	Consumption
	1,000 short tons K_2O	
1960	9,600	9,040
1961	9,670	9,370
1962	10,320	9,560
1963	10,820	10,230
1964	11,900	11,060
1965	13,370	12,070
1966	15,180	13,400
1967	16,000	14,310
1968	16,860	13,580
1969	17,510	16,130
1970	18,430	17,020
1971	19,520	18,190
1972	21,210	19,270
1973 1/	23,700	20,320

1/ Estimated.

Source: FAO Annual Fertilizer Review, 1963 for years 1960-63, 1964 for 1964, 1965 for 1965, 1966 for 1966, 1972 for 1967-72.

Table 11--Estimated world potash production, demand, and balance, by region, 1974

Region	Production	Consumption	Balance
	1,000 short tons K_2O		
North America	9,090	5,150	3,940
West Europe	5,810	5,630	180
East Europe & USSR	7,720	7,180	540
Japan	0	750	-750
Other developed nations 1/	960	400	560
Developed regions	23,580	19,110	4,470
Latin America	0	1,060	-1,060
Developing Africa	370	190	180
Developing Asia	0	790	-790
Developing regions 2/	370	2,040	-1,670
Other Asia 3/	110	250	-140
World	24,070	21,400	2,670

See footnotes and source in table 5.

UNITED STATES FERTILIZER OUTLOOK: 1980

Demand

Total nitrogen use in 1980 is expected to increase from the 8.3 million tons used in 1973 and the 9.3-million tons expected demand in 1974 to 10.4 to 10.8 million tons in 1980 (table 12). The effect of a 24-percent increase in nitrogen application rates on total nitrogen requirements is offset somewhat by a 6 to 10-percent reduction in crop acreages. The 1980 phosphate consumption is projected at 5.7 to 6 million tons. Potash use is expected to increase to 5.4 to 5.5 million tons.

These projections are based on forecasted fertilizer application rates and acres required to produce the food and fiber needed to satisfy domestic and export needs. Domestic requirements are based on the expected population level, personal disposable incomes, and per capita consumption levels. The U.S. civilian population level is assumed at 224.1 million by 1980, an increase of 15.9 million over 1972. Incomes are expected to continue to rise so that the 1980 per capita consumption level of meats will increase while cereals will decline (table 13).

Two alternatives for exports of U.S. farm production were assumed. 2/ The low export alternative assumes a return to longer-run trends from current high export levels. It assumes the enlarged European Community would move towards self-sufficiency; the USSR would return to self-sufficiency from current high levels of imports; Eastern Europe would move to a lower level of imports; the developing nations would demand only moderate amounts of grain; and PL 480 shipments would continue at a low level.

A higher export alternative would occur if the USSR and Eastern Europe significantly increase livestock consumption by importing grain and oilseeds, the People's Republic of China imports more grain to improve diets in urban areas, the enlarged European Community continues significant imports despite the drive towards self-sufficiency, and the livestock economies in the developing world expand.

Crop yields are projected to continue to increase at near the recent trends as farmers adopt improved seed varieties, more efficient use of fertilizers, more efficient machinery, and other improved cultural practices. Corn yields are projected at 115 bushels in 1980, compared with the 91-bushel average in 1973; wheat yields at 36 bushels, compared with 32; soybean yields at 31.5 bushels, compared with 27.8 in 1973; and cotton yields at 520 pounds, compared with 513 pounds.

2/ Depending on magnitude and duration of the energy shortage, there might be substantial deviations from the world supply, demand, and trade projections underlying the assumed U.S. export levels used in this report.

To attain the higher yields, the rates of fertilizer used must increase (table 14). Nitrogen use per acre of crops harvested is expected to increase from 55 pounds per acre in 1974 to 68 pounds in 1980. The greatest increases will occur on corn and wheat.

Gradual increases in phosphate application rates experienced the past few years are expected to continue through 1980. Application rates should reach 38 pounds per acre, compared with 32 pounds per acre in 1974. Potash consumption is expected to increase faster than phsophate, primarily due to substantially increased use on wheat and soybeans. Application rates on soybeans are expected to increase from 18 pounds per acre in 1974 to 24 pounds per acre in 1980, and on wheat from 6 pounds per acre to 16 pounds per acre. Overall, the potash application rates should increase from 28 pounds per acre in 1974 to 35 pounds per acre in 1980.

Under both export alternatives, fewer acres will be needed to fulfill total demand requirements in 1980 than in 1973 for wheat, rice, oats, barley, flaxseed, peanuts, cotton, and dry beans (tables 15 and 16). Under the low export level, fewer acres will also be needed for corn and sorghum grains. The higher export level requires a total 317 million acres, compared to 322 in 1973 and 339 expected in 1974. The low export production will require 305 million acres. Corn and soybeans account for three-fourths of the acreage change between the high and low export levels.

If more of our available land were used to produce the food and fiber in 1980, fertilizer requirements could be reduced since land and fertilizer substitute for one another to a limited extent. However, while expenditures for fertilizer would be reduced, expenditures for nearly all other inputs used in crop production would increase. For example, additional equipment would be required and would substantially increase not only investment costs but also maintenance costs. Additional quantities of fuel, labor, pesticides, and seed also would be required. Cash rent would increase as would crop insurance, and miscellaneous other expenses. Consequently, with expected price relationships, the benefits of reduced fertilizer cost would be more than offset with increases in expenditures for most other items.

Fertilizer Production Capacity and Production

Although the United States has a tight nitrogen balance, the prospects for greater domestic nitrogen output are limited because of the shortage of natural gas. Two ammonia plants are now being erected. One is due to begin production by the end of 1974 and the other by the first quarter of 1975. These plants are designed to supply 765,000 tons ammonia annually. It is also expected that one additional plant will be built in the United States by 1980. These additions will raise our capacity for domestic production of nitrogen for fertilizer use to about 11.1 million tons.

Capacity to produce wet process phosphoric acid in the United States is 6.5 million tons P_2O_5 annually. Five additional plants are scheduled to

Table 12--Projected acres of crops harvested, and fertilizer requirements under two alternatives, United States, 1980

Crops	Low commodity export: Acreage harvested	Low commodity export: Requirements	High commodity export: Acreage harvested	High commodity export: Requirements
	Million acres	1,000 tons	Million acres	1,000 tons
		Nitrogen		
Corn	59.0	4,040	62.7	4,290
Wheat	46.4	1,090	47.8	1,120
Cotton	11.0	320	11.1	320
Soybeans	56.5	110	62.1	120
Total specified crops	172.9	5,560	183.7	5,850
Other crops	131.8	4,840 1/	133.2	4,950 1/
Total	304.7	10,400	316.9	10,800
		Phosphate		
Corn	59.0	1,800	62.7	1,910
Wheat	46.4	460	47.8	480
Cotton	11.0	180	11.1	180
Soybeans	56.5	450	62.1	500
Total specified crops	172.9	2,890	183.7	3,070
Other crops	131.8	2,310 1/	133.2	2,430 1/
Total	304.7	5,000	316.9	6,000
		Potash		
Corn	59.0	1,860	62.7	1,970
Wheat	46.4	370	47.8	380
Cotton	11.0	140	11.1	140
Soybeans	56.5	680	62.1	750
Total specified crops	172.9	3,050	183.7	3,240
Other crops	131.8	2,250 1/	133.2	2,260 1/
Total	304.7	5,300	316.9	5,500

1/ Includes an allowance for use on nonharvested crops and for nonfarm use.

Table 13--U.S. civilian per capita consumption of specified foods, selected averages and years with projections from 1973 to 1980 and 1985

Commodity	Averages		1972	1980
	1959-61	1969-71		
	Pounds			
Beef and veal 1/	90.5	115.5	118.2	135.0
Pork 1/	64.8	68.1	67.4	69.0
Lamb and mutton 1/	4.9	3.3	3.3	2.0
Chicken 2/	29.0	40.7	42.9	48.1
Turkey 2/	6.6	8.3	9.1	10.5
Eggs	44.2	40.8	40.2	39.0
Dairy 3/	654	563	562	53.0
All animal products 4/	101.8	102.5	103.6	107.8
Wheat (grain equivalent)	165.3	152.6	152.6	148.6
Rice (rough basis) 5/	9.0	9.7	12.6	13.2
Corn (grain only)	47.5	61.1	64.2	64.5
Oats	7.5	7.0	7.0	7.0
Peanuts (farmers' stock basis)	6.8	7.8	8.1	8.5
Food fats and oils (fat content)				
Animal	19.1	14.4	13.3	11.4
Vegetable	27.0	38.7	39.1	46.6
Fruit 6/				
Citrus	82.6	93.1	98.1	109.5
Noncitrus	108.7	101.1	94.9	100.3
Vegetables 6/				
Fresh	103.4	99.0	98.2	90.5
Canned and frozen	96.6	114.4	115.3	125.5
Melons 6/	22.5	22.9	21.5	21.1
Potatoes 6/	108.7	118.1	120.0	127.0
Sweetpotatoes	6.2	4.0	5.5	4.8
Dry edible beans and peas 7/	8.2	6.5	6.4	6.0
All crop products 4/	100.6	102.6	103.8	108.0
All foods 4/	101.3	102.5	103.7	107.9

1/ Carcass weight. 2/ Ready-to-cook weight. 3/ Milk equivalent. 4/ Constant retail price weighted index (1967=100). 5/ Historical data excluded territories which have high per capita rates, beginning in 1972, data include shipments to territories. 6/ Fresh equivalent. 7/ Cleaned basis.

SOURCE: Food, Consumption, Prices, Expenditures, Agricultural Economic Report No. 138, and Supplement for 1971, Econ. Res. Serv., U.S. Dept. Agr., Aug. 1972.

Table 14 -Fertilizer application rates, United States, selected years

	Application rate			
	1968	1973	1974 1/	1980 1/
	Pounds per acre			
Nitrogen:				
Corn	96	106	110	137
Wheat	20	30	32	47
Cotton	58	54	55	58
Soybeans	3	3	3	4
Average--all harvested crops	47	52	55	68
Phosphate (P_2O_5):				
Corn	57	55	59	61
Wheat	14	17	17	20
Cotton	32	29	30	32
Soybeans	10	13	13	16
Average--all harvested crops	31	31	32	38
Potash (K_2O):				
Corn	55	57	59	63
Wheat	6	6	6	16
Cotton	25	24	25	26
Soybean	12	18	18	24
Average--all harvested crops	26	27	28	35

1/ Estimated.

Table 15--Production, yield, and acreage requirement with low export alternative, United States, 1980

Commodity	Unit	1980 production: Food	1980 production: Non-food	1980 production: Net export	1980 production: Total	1980 yield per harvested acre	1980 acres harvested requirements: Food	1980 acres harvested requirements: Non-food	1980 acres harvested requirements: Net export	1980 acres harvested requirements: Total	1973 acres harvested	1980 acres less '73 actual level
		Million units					1,000 acres					
Wheat	bu.	550	360	750	1,660	35.8	15,363	10,056	20,950	46,369	53,875	-7,506
Rye	bu.	6.0	32.0	7.3	45.3	28.1	214	1,139	260	1,612	1,038	574
Rice (rough basis)	cwt.	30.5	14.5	63.0	108	51.5	592	282	1,223	2,097	2,170	-73
Corn	bu.	475	5,165	1,150	6,790	115	4,130	44,913	10,000	59,044	61,760	-2,716
Sorghum grain	bu.	9	800	170	979	64	141	12,500	2,656	15,297	15,940	-643
Oats	bu.	91	700	10	801	60	1,517	11,667	167	13,350	14,110	-710
Barley	bu.	160	315	20	495	52	3,077	6,058	385	9,519	10,527	-1,008
Total feed grains	bu.	735	6,980	1,350	9,065		8,865	75,138	13,208	97,210	102,337	-5,127
Noncitrus fruit	ton	11.23	.05	-.74	10.54	4.4	2,552	11	-168	2,395		
Citrus fruit	ton	12.26		1.54	13.80	11.1	1,105		139	1,243		
Vegetables	cwt.	532	3	-5.00	530	146.2	3,639	21	-34	3,625		
Soybeans	bu.		1,030	750	1,780	31.5		32,698	23,810	56,510	56,416	94
Flaxseed	bu.		12	10	22	13.3		902	752	1,654	1,725	-71
Peanuts (farm stock)	bu.	1,960	1,302	733	3,995	2,720	721	479	269	1,469	1,500	-31
Cotton	lbs.		3,792	1,950	5,742	520		7,292	3,750	11,042	11,989	-947
Sugar cane & beets	ton	48.5		0	48.5	23.9	2,029			2,029	1,970	59
Tobacco	lbs.		1,810	610	2,420	2,086		868	292	1,160	892	268
Potatoes, Irish	cwt.	284.6	58.0	2	344.6	251	1,134	231	8	1,373	1,303	70
Dry beans	lbs.	1,044	72	595	1,711	1,437	727	50	414	1,191	1,390	-199
Dry peas	lbs.	44	140	105	289	1,812	24	77	58	159	136	23

Table 16--Production, yield and acreage requirement with high export alternative, United States, 1980

Commodity	Unit	1980 production				1980 yield per harvested acre	1980 acres harvested requirement				Increased acres over low export alternative	1973 acres harvested	1980 acres less 1973 actual level
		Food	Non-food	Net export	Total		Food	Non-food	Net export	Total			
		Million units					1,000 acres						
Wheat	bu.	550	360	800	1,710	37.5	15,363	10,055	22,346	47,765	1,396	53,875	-6,110
Rye	bu.	6.0	32.0	7.3	45.3	28.1	214	1,139	260	1,612		1,038	574
Rice (rough basis)	cwt.	30.5	14.5	65.0	110.0	51.5	592	282	1,262	2,136	39	2,170	-34
Corn	bu.	475	5,165	1,575	7,215	115	4,130	44,913	13,696	62,739	3,695	61,760	979
Sorghum grain	bu.	9	800	250	1,059	64	141	12,500	3,907	16,547	1,250	15,940	607
Oats	bu.	91	700	15	806	60	1,517	11,667	250	13,433	83	14,110	-677
Barley	bu.	160	315	30	505	52	3,077	6,058	577	9,712	193	10,527	-815
Total feed grains	bu.	735	6,980	1,870	9,585		8,865	75,138	18,430	102,431	5,221	102,337	94
Noncitrus fruit	ton	11.23	.05	-.74	10.54	4.4	2,552	11	-168	2,395			
Citrus fruit	ton	12.26		1.54	13.80	11.1	1,105		139	1,243			
Vegetables	cwt.	532	3	-5.00	530	146.2	3,639	21	-34	3,625			
Soybeans	bu.		1,030	925	1,955	31.5		32,698	29,365	62,063	5,553	56,416	5,647
Flaxseed	bu.		12	10	22	13.3		902	752	1,654		1,725	-71
Peanuts (farm stock)	bu.	1,960	1,302	733	3,995	2,720	721	479	269	1,469		1,500	-31
Cotton	lbs.		3,792	1,975	5,767	520		7,292	3,798	11,090	48	11,989	-899
Sugar cane and beets	tons	48.5		0	48.5	23.9	2,029			2,029		1,970	59
Tobacco	lbs.		1,810	610	2,420	2,086		868	292	1,160		892	268
Potatoes, Irish	cwt.	284.6	58.0	2	344.6	251	1,134	231	8	1,373		1,303	70
Dry beans	lbs.	1,044	72	595	1,711	1,437	727	50	414	1,191		1,390	-199
Dry peas	lbs.	44	140	105	289	1,812	24	77	58	159		136	23

come onstream toward the end of the year, adding over a million tons to capacity. An additional million tons capacity is proposed for 1975 construction and 400,000 tons by the end of 1976. If carried to conclusion, phosphate production capacity will be 9 million tons by the end of 1976.

Domestic potash production capacity was 3.2 million tons K_2O per year. Although this is well below domestic consumption, domestic capacity is not expected to increase because of the large quantities of Canadian potash nearby.

Fertilizer Nutrient Balance

With domestic nitrogen production growing to 11.1 million tons by 1980 and consumption estimated at 10.4 to 10.8 million tons (depending upon the level of food exports), nitrogen will continue to be in tight balance through 1980 (table 17). A surplus of 3 to 6 percent will be realized, approximately the amount necessary to prevent distribution problems and spot shortages. However, this assumes the United States would not be a net exporter of nitrogen.

Table 17--Fertilizer nutrient balance, United States, 1980

Nutrient	Production	Low commodity export		High commodity export	
		Consumption	Balance	Consumption	Balance
	Million short tons				
Nitrogen.....	11.1	10.4	0.7	10.8	0.3
Phosphate (P_2O_5)......	9.0	5.7	3.3	6.0	3.0
Potash (K_2O)..	3.2	5.3	1/ -2.1	5.5	1/ -2.3

1/ Net imports required to satisfy demand.

The United States should be in good position to import nitrogen to offset exports or to cover increases in consumption over those expected. An American firm is building a 408,000-ton ammonia plant in the West Indies for the U.S. market and another is expected. One plant is under construction in Canada with three more expected. Two plants are under construction in Mexico with two more planned. Although some of this nitrogen will be used in the producing countries, considerable quantities could be exported to the United States. The Canadian and Mexican plants are being built under the assumption that by virtue of their transportation cost advantage they can capture some of the U.S. market. Similarly, the U.S. will be able to outbid other potential buyers since transportation costs, which account for a major portion of total delivered cost, will be considerably below those of competitors. With estimated imports of about 2 million tons, the U.S. supply of nitrogen is expected to be 13 million tons. Although nitrogen prices may fall below current levels, they will not decline to the low levels of the recent past.

The tight phosphate situation will ease as the new plants begin producing. By 1975 or 1976, phosphate production should exceed demand substantially.

This will support our role as a primary phosphate exporter. Prices should begin to decline at that time.

The United States has been a potash importer and will continue to be. With the world's largest potash reserves just across the U.S.-Canadian border, the United States should have little difficulty obtaining needed supplies. The price of potash will increase with the cost of production.

WORLD FERTILIZER OUTLOOK: 1980 3/

Nitrogen

World nitrogen fertilizer production capacity is expected to reach 63.7 million tons by 1978. This estimate is based on current capacity plus known planned additions. If plants operate at 95 percent of capacity in developed regions and at 70 percent of capacity in LDC's, production will be 56.6 million tons. Demand is expected to reach 56 million tons by 1978. Thus, supply and demand will continue to be in tight balance at that time.

By 1980, world demand for nitrogen fertilizer is expected to range from 57 million tons to 64.6 million tons, an increase of 42 to 61 percent over 1973 (table 18). Using the midpoint as the most likely demand in 1980, estimated 1978 capacity will not allow sufficient production to meet this demand. Assuming plants in developed regions will operate at 95 percent of capacity while those in LDC's operate at 70 percent, another 10.1 million tons of capacity will be required to satisfy demand plus allow for a safe margin. At current costs, this represents additional capital investment of $1.1 billion above announced capacity, or $2.5 billion above investment in currently existing facilities.

Recent plant announcements not included in these estimates suggest a strong supply response to current high prices and the anticipated 1980 deficit. The region with the largest expected deficit is Other Asia, primarily the PRC (table 19). However, PRC is reportedly embarking on a major expansion of nitrogen capacity. At least 10 large plants have already been contracted, some of which have been announced since supply estimates were made. Since PRC has a good record of capacity utilization, results of the Chinese program could have a significant impact on the size of the 1980 supply deficit.

3/ Supply estimates are based on known capacity, either existing or planned, that will be available for producing fertilizer. Because 2 to 4 years are required from the decision to build a plant to the actual operation of the plant, capacity estimates really apply to 1977-78 rather than to 1980. Thus, a projection of a deficit indicates how much capacity will be needed in addition to known capacity.

Estimates in this section are based on TVA data, adjusted with ERS data for North America.

Another region showing a sizable deficit and for which few data are available is East Europe-USSR. A recently announced agreement between the USSR and a U.S. oil company involving the construction of several large ammonia plants in the USSR could significantly reduce the 1980 estimated fertilizer supply deficit, since not all of those plants are included in these projections. Full details and implementation schedule of the agreement are at present unannounced.

Developing Asia would also have a substantial supply deficit in 1980 if production capacity is not expanded. Some of the Mideast oil producing countries included in Developing Asia like Kuwait and Iran have been moving into nitrogen fertilizer production in recent years. Current production technology for nitrogen is closely tied to natural gas or naphtha, a petroleum refinery product. Many Mideast countries have these raw materials in abundance at little or no opportunity cost. It therefore seems likely they will continue their trend into nitrogen production, particularly for exports since many have a very limited agricultural base.

The estimated situation in the Americas could also change significantly. The expected new plants in Canada, Mexico, and the Caribbean were mentioned previously. In addition, Bolivia has substantial reserves of natural gas. This gas could very likely move into Brazil, where some of it would be used for fertilizer production.

Although the LDC's share of total nitrogen production will rise from their current 12 percent to nearly 25 percent by 1980, they still will account for much of the world deficit. LDC's must not only commit themselves to expanding capacity, but also to increasing their utilization of capacity. For example, raising their utilization from 70 to 80 percent of capacity would increase their nitrogen supply nearly 1.4 million tons.

Phosphate

The 1980 phosphate situation is not as critical as the nitrogen situation. World demand for phosphate fertilizer is expected to range from 31.2 million tons P_2O_5 to 37.6 million tons by 1980, an increase of 21 to 46 percent over 1973 (table 20). Using the midpoint as the most likely demand in 1980, current capacity plus planned additions should be sufficient to meet anticipated demand. Assuming plants will operate at 95 and 70 percent of capacity in developed countries and LDC's respectively, a surplus of 3.4 million tons will be realized. This is nearly 10 percent of anticipated consumption (table 21). With production at 85 and 60 percent of capacity, the surplus would be only one-half million tons, about 1.5 percent of consumption.

The principal deficit areas are Developing Asia and Latin America. Developing Africa should have a substantial surplus from high levels of production in North Africa. In contrast to the situation for nitrogen, North America (chiefly the United States) will likely remain the world's largest exporter of phosphate fertilizer material and a principal source of supply for the deficit developing regions.

Potash

World demand for potash fertilizer is expected to range from 25.9 million tons K_2O to 30.6 million tons by 1980, an increase of 27 to 50 percent over 1973 (table 22). Using the midpoint as the most likely estimate of demand, current potash capacity will not be sufficient to satisfy demand in 1980. A deficit of nearly 1.7 million tons would be realized. Although no planned additions have been announced, Canadian producers have indicated they will expand as needed to satisfy world demand. With virtually unlimited reserves, Canada will remain the dominant exporter of potash.

Table 18--Estimated nitrogen fertilizer production and consumption, world, by regions, 1978 and 1980

Region	1978 production capacity 1/	1978 production		1980 consumption		
		High 2/	Low 3/	High	Midpoint	Low
	1,000 short tons N					
North America	13,400	12,700	11,400	11,400	11,300	10,900
West Europe	12,900	12,300	11,000	10,700	10,500	10,200
East Europe and USSR	16,100	15,300	13,700	18,200	17,200	16,300
Japan	4,000	3,800	3,400	1,200	1,000	800
Other developed nations 4/	800	800	700	1,000	800	600
Developed regions	47,200	44,900	40,200	42,500	40,800	38,800
Latin America	4,100	2,900	2,500	3,600	3,400	3,100
Developing Africa	1,100	800	700	1,600	1,400	1,200
Developing Asia	8,500	6,000	5,200	8,600	7,800	7,000
Developing regions 5/	13,700	9,700	8,400	13,800	12,600	11,400
Other Asia 6/	2,700	2,000	1,800	8,300	7,500	6,800
World	63,700	56,600	50,400	64,600	60,900	57,000

1/ Known production capacity for 1978 based on current capacity plus planned additions.
2/ Based on plants in developed countries operating at 95 percent of 1978 capacity and in LDC's at 70 percent.
3/ Based on plants in developed countries operating at 85 percent of 1978 capacity and in LDC's at 60 percent.
4/ Includes South Africa, Israel, and Oceania.
5/ Excluding Other Asia.
6/ Includes PRC, Taiwan, North Korea, North Vietnam, and Mongolia.
Source: Based on TVA and unpublished USDA data.

Table 19--Estimated nitrogen fertilizer balance, world, by regions, 1980

Region	High production 1/	Low production 2/
	1,000 short tons N	
North America	3/ 1,400	100
West Europe	1,800	500
East Europe and USSR	-1,950	-3,560
Japan	2,800	2,400
Other developed nations 4/	60	-40
Developed regions	4,110	-550
Latin America	-530	-930
Developing Africa	-550	-650
Developing Asia	-1,800	-2,640
Developing regions 5/	-2,880	-4,220
Other Asia 6/	-5,520	-5,755
World	-4,290	-10,525

1/ Based on midpoint of demand with plants in developed regions operating at 95 percent of 1978 capacity and LDC's at 70 percent.
2/ Based on midpoint of demand with plants in developed regions operating at 85 percent of 1978 capacity and LDC's at 60 percent.
3/ Positive numbers imply surplus; negative numbers imply deficit.
4/ Includes South Africa, Israel, and Oceania.
5/ Excludes Other Asia.
6/ Includes PRC, Taiwan, North Vietnam, North Korea, and Mongolia.

Source: Based on TVA and unpublished USDA data.

Table 20--Estimated phosphate fertilizer production and consumption, world, by regions, 1978 and 1980

Region	1978 production capacity 1/	1978 production		1980 consumption		
		High 2/	Low 3/	High	Midpoint	Low
	1,000 short tons P_2O_5					
North America	10,280	9,900	8,930	7,200	6,700	6,200
West Europe	8,300	8,030	7,450	8,220	7,920	7,620
East Europe and USSR	10,020	9,700	9,070	8,400	8,140	7,810
Japan	1,050	1,000	910	1,000	810	630
Other developed nations 4/	2,370	2,340	2,130	2,790	2,140	1,490
Developed regions	32,050	30,970	28,510	27,680	25,710	23,750
Latin America	1,950	1,470	1,320	2,730	2,540	2,360
Developing Africa	2,470	1,900	1,710	790	710	640
Developing Asia	2,160	1,630	1,450	3,190	2,770	2,350
Developing regions 5/	6,590	4,680	4,480	6,700	6,020	5,340
Other Asia 6/	1,920	1,890	1,880	2,320	2,110	1,900
World	40,560	37,540	34,870	36,700	33,840	30,990

1/Known production capacity for 1978 based on current capacity plus planned additions.
2/Based on plants in developed countries operating at 95 percent of 1978 capacity and in LDC's at 70 percent.
3/Based on plants in developed countries operating at 85 percent of 1978 capacity and in LDC's at 60 percent.
4/Includes South Africa, Israel, and Oceania.
5/Excluding Other Asia.
6/Includes PRC, Taiwan, North Korea, North Vietnam, and Mongolia.
Source: Based on TVA and unpublished USDA data.

Table 21--Estimated phosphate fertilizer balance, world, by regions, 1980

Region	High production 1/	Low production 2/
	1,000 short tons P_2O_5	
North America	3/ 3,200	2,250
West Europe	110	-470
East Europe and USSR	1,560	930
Japan	190	90
Other developed nations 4/	180	110
Developed regions	5,220	2,840
Latin America	1,070	-1,220
Developing Africa	1,190	1,000
Developing Asia	-1,140	-1,320
Developing regions 5/	-1,010	-1,540
Other Asia 6/	-220	-230
World	3,990	1,070

1/ Based on midpoint of demand with plants in developed regions operating at 95 percent of 1978 capacity and LDC's at 70 percent.
2/ Based on midpoint of demand with plants in developed regions operating at 85 percent of 1978 capacity and LDC's at 60 percent.
3/ Positive numbers imply surplus; negative numbers imply deficit.
4/ Includes South Africa, Israel, and Oceania.
5/ Excludes Other Asia.
6/ Includes PRC, Taiwan, North Vietnam, North Korea, and Mongolia.

Source: Based on TVA and unpublished USDA data.

Table 22--Estimated potash fertilizer production and consumption, world, by regions, 1978 and 1980

Region	1978 production capacity 1/	1978 production 2/	1980 consumption		
			High	Midpoint	Low
	1,000 short tons K_2O				
North America	10,390	9,090	6,940	6,510	6,080
West Europe	7,400	6,470	6,960	6,550	6,130
East Europe and USSR	11,200	9,800	10,680	9,870	9,060
Japan	0	0	970	820	670
Other developed nations 3/	820	730	600	500	420
Developed regions	29,810	26,090	26,150	24,250	22,360
Latin America	0	0	2,270	2,040	1,820
Developing Africa	500	370	330	290	240
Developing Asia	0	0	1,390	1,290	1,190
Developing regions 4/	550	370	3,980	3,620	3,250
Other Asia 5/	130	110	360	360	270
World	29,860	26,580	30,600	28,240	25,870

1/ Known production capacity for 1978 based on current capacity plus planned additions.
2/ Based on plants in developed countries operating at 95 percent of capacity and in LDC's at 70 percent.
3/ Includes South Africa, Israel, and Oceania.
4/ Excluding Other Asia.
5/ Includes PRC, Taiwan, North Korea, North Vietnam, and Mongolia.
Source: Based on TVA and unpublished USDA data.

FERTILIZER PRODUCTION TECHONOLOGY AND RESOURCE RESERVES 4/

Nitrogen

Nitrogen is a colorless, odorless gas and comprises about 4/5 of the earth's atmosphere. Thus, the supply is virtually limitless. However, in its atmospheric form, nitrogen is not readily available to most growing plants. To be usable as a fertilizer, nitrogen is united with other elements to produce chemical compounds that can easily be applied to soils and release its nitrogen for use by growing plants.

Technology

Nitrogen is combined with hydrogen to produce synthetic anhydrous ammonia (NH_3), the base product for nearly all nitrogen fertilizers used in the United States and most of those used throughout the world. Although any hydrogen feedstock may be used, its adequacy and cost greatly determine the cost of producing ammonia. Natural gas--methane (CH_4)--is used in the United States for production of nearly all synthetic ammonia because it has been the cheapest source of hydrogen. In Europe, fuel oil, coal, and naptha have been widely used. Although hydrogen obtained by hydrolyzing water can also be used, as it is in Norway, extremely low-cost electric power must be available for the process to be economical.

Two generations of manufacturing plants are used to synthesize ammonia. The first, constructed up until the 1960's, used piston compressors in the system. These plants have capacities ranging from 15,000 tons to 200,000 tons or more of ammonia per year. The second generation of plant uses centrifugal compressors operated by steam turbines. Typical production of these plants is 340,000 to 510,000 tons of ammonia per year, allowing a 25-35 day-per-year shutdown for maintenance. Both plant designs utilize steam to reform the hydrocarbons from the feedstock into hydrogen and carbon oxides. After purification, the hydrogen is combined with atmospheric nitrogen to make ammonia.

Based on current investment and operating costs, large centrifugal plants utilizing a natural gas feedstock are most economical. Consequently, countries with abundant resources of natural gas have a high nitrogen production potential.

4/ This section draws heavily from materials provided by the Bureau of Mines.

World natural gas reserves recoverable at the end of 1971, at an average wellhead price of 18.2 cents per thousand cubic feet, were estimated to be 1,169 trillion cubic feet. The U.S. proved reserves recoverable under existing economic and operating conditions at the end of 1971 totaled 279 trillion cubic feet. There is no international standard to define natural gas reserves, thus it can be misleading to compare the U.S. reserves with that of other nations. However, an assessment of world natural gas recoverable at various prices is shown in table 23. During 1962 to 1971, the U.S. proved reserves of natural gas, reported by the American Gas Association, increassed from 272.3 trillion cubic feet to 278.8 trillion cubic feet. However, the reserves-to-production ratio (R/P) declined from 20.0 to 1 in 1962 to 12.6 to 1 in 1971. Discounting the North Slope reserves, the 1971 R/P would be 11.5 to 1. The reserves-to-production ratio in the rest of the world in 1971 was 83 to 1.

Although the United States has a sizable reserve, it is being drawn down rapidly. On the other hand, Asian, North African, and the Central Planning Countries (USSR, China, and Mongolia) have considerable natural gas supplies, particularly with respect to their production. Thus, their potential for increasing ammonia production is substantial.

If petroleum products are used to produce ammonia, Asia and Africa by virtue of their reserves again have great potential for expanding ammonia production (table 24). Coal is seldom used as a hydrogen feedstock for producing ammonia since it is considerably more expensive than the alternatives. However if technological improvements facilitate gasification of coal, the United States will be in an improved position. The United States has virtually all of the world's recoverable reserves at current prices (table 25 & 26).

Products

In its pure state, ammonia is 82.24 percent nitrogen and 17.76 percent hydrogen by weight. In 1972, 74 percent of the domestically fixed ammonia was used for nitrogen fertilizer. In addition to being used as a fertilizer material itself, ammonia is used either directly or indirectly to produce most other nitrogen fertilizer products (table 27). Over the past 4 years, direct application of anhydrous ammonia has provided 38 percent of the nitrogen used in the United States (table 28). Direct application of aqua ammonia, ammonium nitrate, ammonium sulfate, nitrogen solutions, urea, and various other nitrogen-carrying fertilizers accounted for 36 percent of the nitrogen used during this period and nitrogen in mixed fertilizers accounted for the remaining 26 percent.

Ammonia not used in producing fertilizer is used in manufacturing plastics (6 percent), manufacturing explosives (4 percent), food processing, producing feed urea, manufacturing pulp for high-quality paper, stabilizing synthetic rubber during transportation and storage, and for a wide variety of other uses (fig. 6).

Table 23--Assessment of natural gas recoverable at various wellhead prices, world, by regions and countries 1/

Country	Price constant 1971 dollars per 1,000 cubic feet			
	$0.182 2/	$0.34	$0.44	$0.55 +
	Trillion cubic feet			
North America:				
United States	279	580	900	2,349
Other	40	480	950	1,750
Total	319	1,060	1,850	4,099
South America	90	600	1,000	1,280
Europe 3/	30	200	410	640
Asia 4/	250	1,450	1,800	2,100
Africa	170	1,400	2,030	2,700
USSR, China and Mongolia	300	1,300	3,000	4,230
Australia, East Indies, and Pacific Islands	10	120	330	550
Total	1,169	6,130	10,420	15,599

1/ There is insufficient information to determine the availability of undiscovered resources at various prices.
2/ 1971 average price, $0.182 per 1,000 cubic feet.
3/ Excludes USSR
4/ Excludes China, Mongolia, and East Indies.
Source: Bureau of Mines.

Table 24--Assessment of crude oil recoverable at various prices, world, by regions and countries

Country	Average 1972 price 1/	Proved reserves 2/	100 percent increased price	Proved reserves 3/
	Dollars	Billion barrels	Dollars	Billion barrels
North America:				
United States	3.39	36.3	6.78	39.9
Other	2.97	15.0	5.94	16.5
Total	---	51.3	---	56.4
South America	2.30	28.3	4.60	31.1
Europe	4/ 3.25	90.6	6.50	99.7
Africa	3.40	106.4	6.80	117.0
Asia	2.43	388.0	4.86	426.8
Oceania	2.60	2.3	5.20	2.5
Total	---	666.9	---	733.5

1/ U.S. price from Bureau of Mines. Others are posted prices from representative countries (constant 1972 dollars per barrel).
2/ From American Petroleum Institute and Oil and Gas Journal.
3/ Data to quantify reserve-price relationships are not available. For planning purposes it was assumed that a 100-percent increase in price would increase reserves by 10 percent.
4/ Estimated.
Source: Bureau of Mines.

Table 25--Assessment of bituminous coal resources recoverable at various prices, world, by regions and countries 1/

Country	Price, constant 1971 dollars per ton			
	$7.13 2/	$20.00	$25.00	+$25.00
	Million Short Tons			
North America:				
United States	65,000	130,000	230,000	548,000
Canada	---	5,000	20,000	33,500
Other	---	500	1,000	1,900
Total	65,000	135,500	251,000	583,000
South America:				
Brazil	---	1,000	3,000	5,870
Colombia	---	1,000	3,000	6,875
Other	---	500	1,000	1,680
Total	---	2,500	7,000	14,425
Europe:				
Belgium	---	---	500	990
Czechoslovakia	---	---	3,000	6,365
France	---	---	1,000	1,540
West Germany	---	---	20,000	38,500
Netherlands	---	---	1,000	1,315
Poland	---	---	15,000	25,160
Spain	---	---	1,000	1,560
USSR	---	---	1,000,000	2,266,880
United Kingdom	---	---	4,500	8,525
Other	---	---	1,000	1,733
Total	---	---	1,047,000	2,352,568
Africa:				
South Africa	---	4,000	20,000	39,860
Other	---	1,000	3,500	7,490
Total	---	5,000	23,500	47,350
Asia:				
People's Rep. of China	---	50,000	275,000	556,050
India	---	6,000	30,000	58,440
Japan	---	1,000	5,000	10,585
Other	---	400	2,000	4,060
Total	---	57,400	312,000	629,135
Oceania:				
Australia	400	1,000	4,500	8,800
New Zealand	---	---	200	460
Total	400	1,000	4,700	9,260
World total	65,400	201,400	1,645,200	3,636,138

1/ Anthracite reserves are included for all countries except the United States.
2/ Approximate 1971 average domestic mine price.
Source: Bureau of Mines.

Table 26--Assessment of lignite resources recoverable at various prices, world, by regions and countries 1/

Country	Price, constant 1971 dollars per ton			
	$2.03 2/	$8.00	$12.00	+$16.00
	Million short tons			
North America:				
United States	25,000	50,000	125,000	224,000
Canada	---	5,000	10,000	13,000
Total	25,000	55,000	135,000	237,000
Europe:				
Austria	---	---	50	75
Bulgaria	---	---	400	615
Czechoslovakia	---	---	3,000	5,420
France	---	---	20	50
Germany:				
East	---	---	10,000	16,500
West	---	---	20,000	34,000
Greece	---	---	400	850
Hungary	---	---	2,000	3,120
Poland	---	---	4,000	8,175
Rumania	---	---	400	750
USSR	---	---	400,000	775,000
Yugoslavia	---	---	7,000	14,600
Total	---	---	447,270	859,155
Asia:				
People's Rep. of China	---	---	100	385
India	---	100	500	1,100
Turkey	---	100	500	1,050
Total	---	200	1,100	2,535
Oceania:				
Australia	---	5,000	25,000	52,500
New Zealand	---	---	100	210
Total	---	5,000	25,100	52,710
Other countries	---	1,000	3,500	7,142
World total	25,000	61,200	611,970	1,158,542

1/ Anthracite reserves are included for all countries except the United States.
2/ Approximate 1971 average domestic mine price.
Source: Bureau of Mines.

Table 27 --Quantities of materials required to produce specified fertilizer products

Product being produced	Anhydrous ammonia	Nitric acid	Ammonium nitrate	Urea	Phosphate rock	Sulfuric acid	Phosphate acid	Elemental phosphate	Elemental sulfur	Superphosphoric acid	Sylvite ore
	Material required to produce 1 ton of specified product										
	Tons										
Nitric Acid (60%)	0.292										
Ammonium Nitrate (33.5-0-0)	0.208	0.765									
Urea (45-0-0)	0.58										
Nonpressure Nitrogen Solution (28%)			0.388	0.310							
Low pressure Nitrogen Solution (37%)	0.158		0.585	0.077							
Nitrogen Manufacturing Solution (44%)	0.238		0.698								
Aqua Ammonia (24-0-0)	0.294										
Elemental Phosphorus (229%)					5.1527						
Phosphoric Acid (54%)					1.85	1.47					
Superphosphoric Acid (72%)							0.780	0.131			
Sulphuric Acid (98%)									0.35		
Ammonium Polyphosphate (10-34-0)	0.121						0.630				
or	0.121									0.473	
Ammonium Polyphosphate (11-37-0)	0.134									0.514	
Normal superphosphate (0-20-0)					0.626	0.390					
Concentrated Superphosphate (0-46-0)					0.417		0.644				
Diammonium Phosphate (18-46-0)	0.2195						0.8518				
Monoammonium phosphate (13-52-0)	0.1585						0.963				
Potassium Chloride (0-0-60)											2.60

Source: Bell, David M., Dennis R. Henderson, and George R. Perkins, A Simulation of the Fertilizer Industry in the United States: With Special Emphasis on Fertilizer Distribution in Michigan. Mich. State Univ., Agr. Econ. Rpt. No. 189, East Lansing, Feb. 1972.

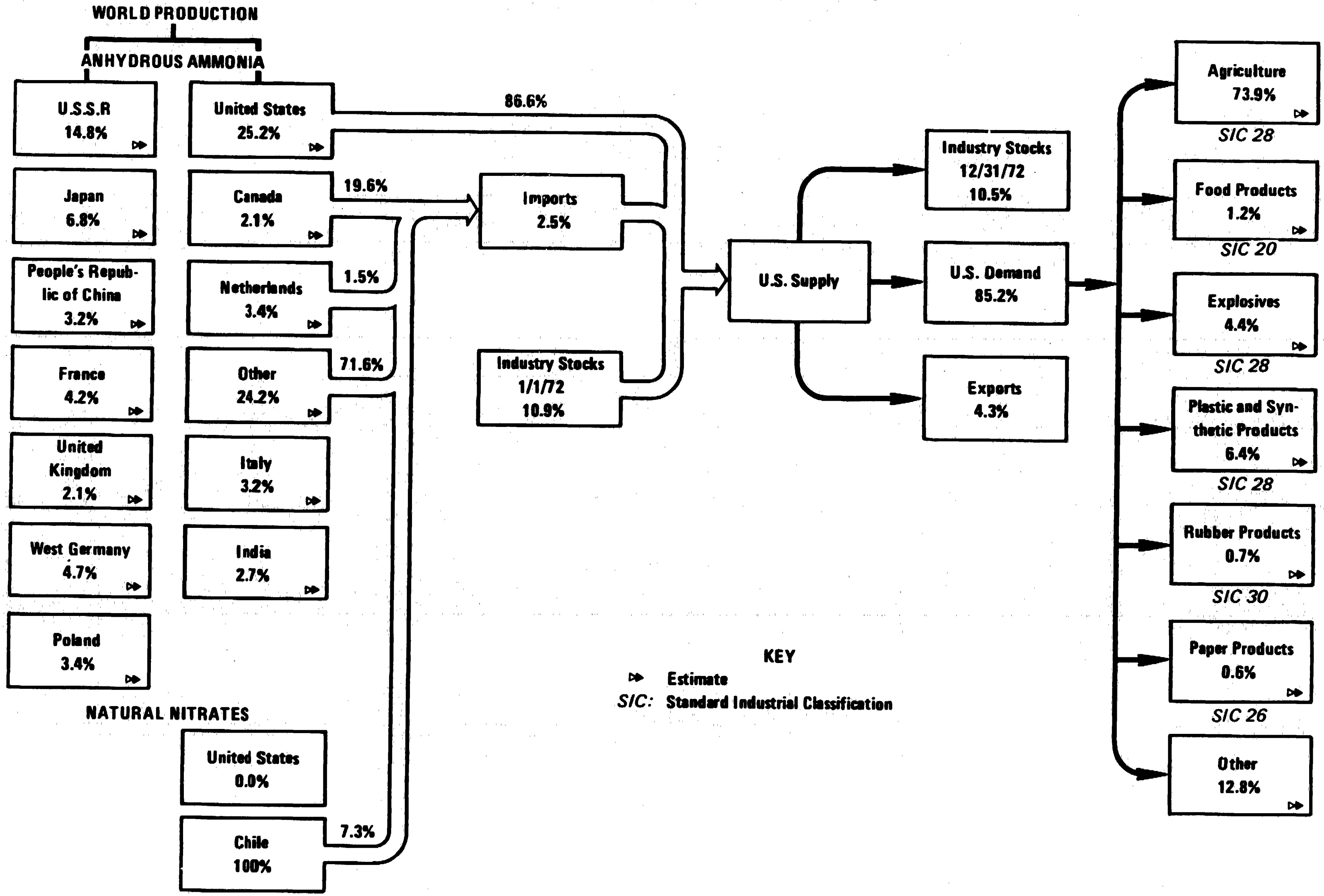
Table 28--Consumption of fertilizer materials by direct application, United States, years ending June 30, 1965 and 1970-73

Material	1965	1970	1971	1972	1973
			1,000 tons		
Anhydrous Ammonia	1,563	3,468	3,968	3,637	3,581
Aqua Ammonia	820	701	738	733	714
Ammonium Nitrate	1,634	2,144	2,843	3,031	3,221
Ammonium Sulfate	775	782	902	934	828
Nitrogen Solutions	1,922	3,243	3,482	3,420	3,680
Sodium Nitrate	301	86	99	97	58
Urea	428	534	601	785	933
Other Nitrogen	252	240	220	164	240
Phosphate Rock	477	170	122	71	52
Superphosphates:					
(22% or under)	455	312	276	218	177
(Over 22%)	729	1,205	1,220	1,263	1,246
Ammonium Phosphates	720	644	605	607	703
Other Phosphates	155	191	189	216	205
Potassium Chloride (50-62%)	814	2,173	2,269	2,462	2,561
Other Potash	122	237	232	223	186

Source: Commercial Fertilizers; Consumption in the United States, Crop Reporting Board, Statis. Rptg. Serv., U.S. Dept. of Agr., Sp Cr 7, Washington, D.C. Sp Cr 7, Washington, D.C.

Figure 6

Nitrogen supply and demand relationship, 1972



Source: Bureau of Mines.

Phosphorus

Reserves

Deposits of phosphate rock are widespread throughout the world, but those of the greatest importance are in the United States, North Africa, and the USSR (table 29). In South America, the most important deposit is in the Sechura Desert of Peru. Both technical and political problems have prevented it from being developed commercially. Large deposits have been discovered in Australia. Numerous problems associated with these deposits will delay the recovery of phosphorus minerals for several years. Few data are available to analyze the phosphorus potential of Asia. The only known workable deposit in Southeast Asia is in North Vietnam.

In the United States, phosphate deposits have been reported in 23 States but the principal domestic phosphorus sources are in Florida, North Carolina, Tennessee, Idaho, Montana, Wyoming, and Utah.

The commercial deposits in Tennessee, depending on the rate of extraction, will be depleted in 10 to 20 years. Lower grade deposits not currently considered as reserves are available in the area. The producing areas of Florida have been estimated to contain economic ore for continued production through 2000. Northern Florida deposits are not fully evaluated, but should last at least 35 to 40 years. Some of the problems that are associated with Florida operations are low recovery of phosphorus values, high percentage of slime tailings, and rearrangement or the land by strip mining. Improvements in phosphorus recovery, development of acceptable slime dewatering systems, and establishment of land reclamation programs would extend the useful life of the Central Florida district and increase the degree of acceptance of this industry to the State of Florida.

The known reserves reported for the North Carolina deposits are not as large as those in Florida and are being exploited at a much slower rate. The deposits in Idaho, Montana, Wyoming, and Utah are remote from both fertilizer-consuming areas and seaports. Because of high transportation costs, they cannot compete in the eastern market. In addition, the cost of recovering phosphorus from the steeply dipping, thin, discontinuous beds that characterize the western deposits, the variable grades, and other factors also place them at an economic disadvantage. However as the eastern reserves are depleted, demand for the western resources will probably increase.

Technology and Products

Most of the domestically produced phosphate rock is strip mined. In Florida, overburden is stripped and ore is mined by large electric draglines with buckets ranging in capacity from 18 to 49 cubic yards. The ore (matrix) is slurred with water and pumped through 18- to 24-inch diameter steel pieplines to washing plants located up to 6 miles from the mine. In North Carolina, where the overburden is approximately 100 feet, a 72-cubic-yard bucket dragline is used for stripping and mining. In Tennessee and in the

Table 29--Assessment of phosphorus resources (phosphate rock and apatite) recoverable at various prices, world, by regions and countries

Item	Price, constant 1972 dollars per ton of contained phosphorus		
	$58 1/	$86	$144
	Million short tons P		
North America			
United States			
Florida	168	223	349
North Carolina	38	98	279
Tennessee	4	17	84
Idaho	24	279	838
Montana	1	36	168
Utah	27	56	321
Wyoming	1	20	61
Other States	---	14	64
Other Countries	1	4	140
Total	254	747	2,282
South America	22	72	796
Europe			
USSR	126	314	628
Other	5	9	18
Total	131	323	646
Africa			
Algeria	20	46	92
Morocco	75	753	3,764
Spanish Sahara	62	108	155
Tunisia	39	77	116
Other	66	278	551
Total	262	1,262	4,678
Asia			
People's Republic of China	9	37	148
North Vietnam	11	23	61
Israel	6	22	58
Jordan	15	29	NA
Other	9	60	389
Total	50	171	656
Oceania			
Australia	---	84	182
Christmas Island	13	17	---
Other	7	9	---
Total	20	110	182
World total 2/	739	2,685	9.240

1/ 1972, 70 BPL, value $57.64 f.o.b. U.S. plants.
2/ World production in 1972 was 14 million short tons.
Source: Bureau of Mines.

open-pit mines of the West, the ore is mined by 2- to 3-cubic-yard buck power shovels and trucked or transported by train to the plants. Nearly all commercial grade ore is recovered by open-pit mining.

There are two fundamental methods of decomposing phosphate rock to obtain products suitable for fertilizer and industrial purposes in the United States--acid treatment and electric furnace reduction to elemental phosphorus.

For the most part, sulfuric acid is used in the United States to decompose the phosphate rock. To produce normal superphosphate, enough sulfuric acid is added to high-grade phosphate rock to convert the phosphate into water-soluble or available monocalcium phosphate. Calcium sulfate also is produced but is not separated from the mixture. To produce phosphoric acid, additional sulfuric acid is added and the phosphoric acid produced is filtered from the insoluble calcium sulfate. Although the sulfuric acid method is efficient with a recovery of over 90 percent of the phosphorus, a large quantity of impure calcium sulfate is produced and stacked as waste.

Acidulating phosphate rock with phosphoric acid produces triple superphosphate. Phosphoric acid is combined with potash and/or ammonia to product highly concentrated fertilizer--ammonium phosphates and potassium phosphates.

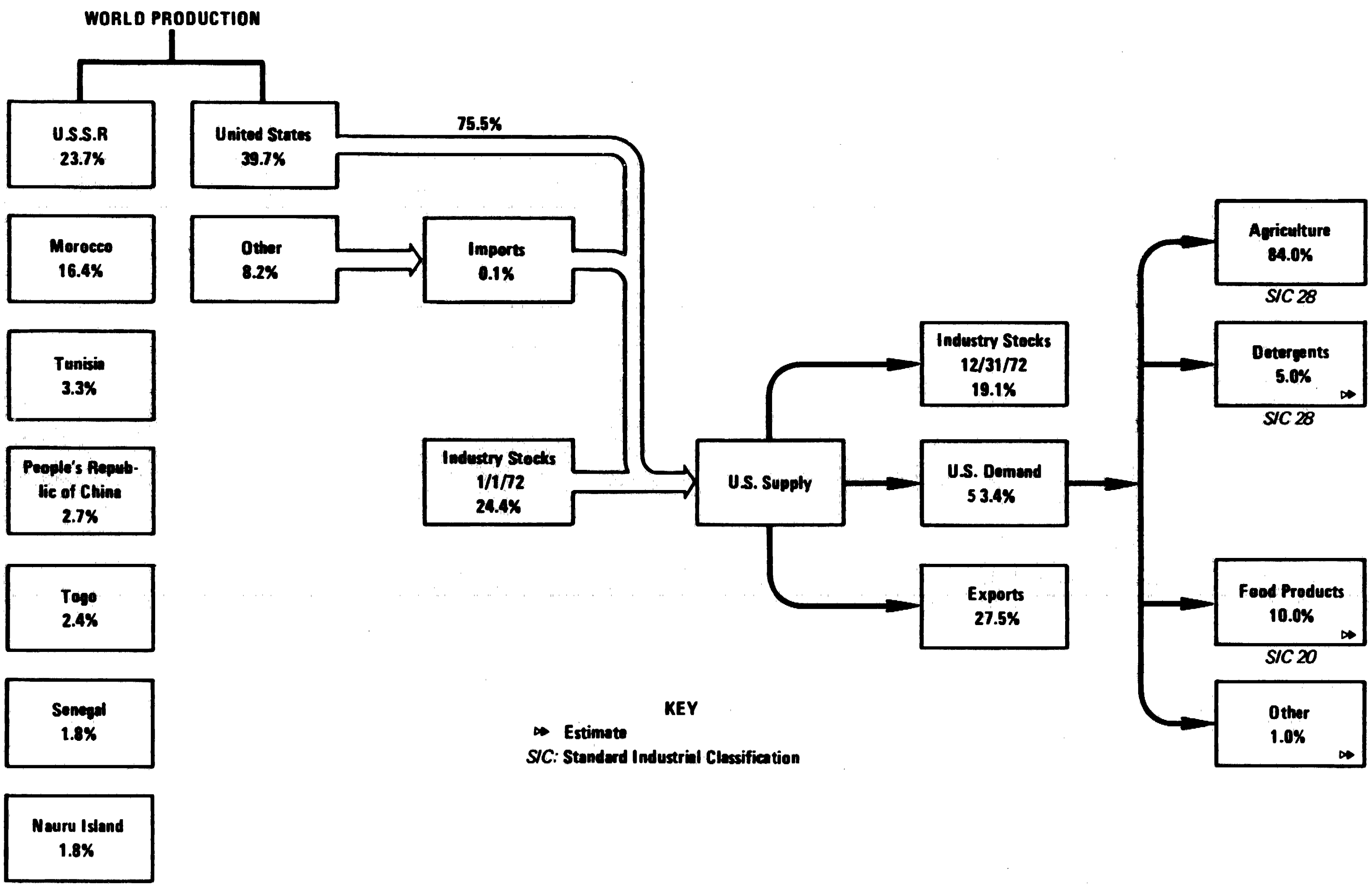
Nitric acid or a combination of nitric and other acids to acidulate phosphate rock have not been used extensively in the United States. The product, because of the hygroscopic calcium nitrate content, must be treated further, usually by ammoniation, to produce a suitable fertilizer product. Nitrophosphatic fertilizers are not popular with U.S. farmers.

The electric furnace-reduction method is based on the smelting of phosphate rock with carbon (coke) and a siliceous flux in electric furnaces. The products are elemental phosphorus, ferrophosphorus, carbon monoxide and a calcium silicate slag. The phosphorus is volatilized, condensed, and collected under hot water as a liquid. The calcium silicate and ferrophosphorus are periodically tapped from the furnace. Carbon monoxide is utilized as a fuel to nodulize the phosphate rock prior to charging to the electric furnace.

The "wet" process using sulfuric acid is by far the most economical method of decomposing phosphate rock, and consequently, accounts for most of the phosphorus produced in the United States. Although the electric furnace is used, its importance is declining and the high quality phosphate produced is directed primarily to nonfertilizer uses.

In 1972, about 84 percent of the U.S. demand for phosphorus was consumed in the manufacture of fertilizers (figure 7). About 10 percent was consumed in animal feeds, while an additional 5 percent was used in the formulation of detergents and cleaning compounds. The remaining 1 percent was consumed in a host of other uses, such as oil refining, textiles, pesticides, plastics, and food processing.

Phosphorus supply and demand relationship, 1972



Source: Bureau of Mines.

Figure 7

Sulfur

Since the production of phosphate fertilizer requires large quantities of sulfuric acid, the supply of sulfur is important in determining the supply of phosphatic fertilizers. Sulfur is of prime importance to every sector of the industrial complexes of the world, but approximately half of the sulfur is used in the manufacture of fertilizer.

Reserves

Sulfur resources are of two basic categories: mined, or recovered, as a prime product, which includes Frasch, pyrites, native sulfur ores and gypsum; and recovered, which includes sulfur recovered as a coproduct of petroleum, natural gas, and nonferrous smelter operations (table 30).

The resource estimates in table 30 do not include the enormous sulfur resources contained in fossil fuels, principally coal, for which a satisfactory recovery process has not yet been developed. If a low-cost technology should be developed, or if environmental considerations should require the production of a marketable sulfur product from this source regardless of economic considerations, the sulfur from coal would completely overshadow the estimates shown in table 30.

It was estimated that domestic and world production for 1972 came to only 85 and 82 percent of installed production capabilities, respectively (table 31). Additionally, both domestic and world production exceeded the demand as reflected in an increase of world stocks of 3.4 million short tons. Therefore, domestic and world demands were only 82 and 76 percent of available production capacity, respectively.

It is estimated that domestic capacity will increase 5 percent by 1975, and for the rest of the world, 21 percent (table 32). Canada is now actively engaged in an expansion program, particularly as it relates to the recovery of elemental sulfur from its rapidly expanding natural gas industry. New plants and expansions scheduled for completion in 1974, for the desulfurization of natural gas, will represent an increase of 6 percent over installed capacity during 1973, with still further additions in the planning stage. Canada is also expanding its production of coproduct sulfuric acid at nonferrous metal smelters, primarily for export, because of environmental considerations.

Similar conditions are facing the domestic sulfur-producing industry, and to a lesser extent the rest of the world. Fundamentally, this will be brought about by the absolute necessity of the removal of sulfur from solid, liquid, and gaseous effluents, or wastes for the protection of the environment. Secondarily, it will be influenced by the foreseeable exhaustion of cheap sources of noncombined sulfur. It is predictable that the enforced production of coproduct sulfur for environmental reasons will completely reverse the present supply pattern. Although 72 percent of current domestic supplies of sulfur are obtained from noncombined sulfur deposits (Frasch type), the long-range expectation is that 93 percent will be obtained from coproduct sources regardless of costs. Additionally, these latter sources will probably provide an overabundance of supply.

Table 30--Assessment of sulfur resources recoverable at various prices, world, by regions and countries

Country	Mined 1/				Recovered 2/				Total			
	Price, constant 1972 dollars per short ton of sulfur											
	16 3/	25	34	43	16	25	34	43	16	25	34	43
	Million short tons											
North America:												
United States	44.8	156.8	795.2	1,982.4	39.2	106.4	173.6	173.6	84.0	263.2	968.8	2,156.0
Canada	5.6	11.2	408.8	1,204.0	425.6	873.6	1,316.0	1,316.0	431.2	884.8	1,724.8	2,520.0
Mexico	11.2	44.8	145.6	341.6	5.6	16.8	22.4	28.0	16.8	61.6	168.0	369.6
Other	---	---	22.4	72.8	---	---	---	---	---	---	22.4	72.8
Total	61.6	212.8	1,372.0	3,600.8	470.4	996.8	1,512.0	1,517.6	552.0	1,209.6	2,884.0	5,118.4
South America	11.2	22.4	151.2	414.4	22.4	61.6	100.8	100.8	33.6	84.0	252.0	515.2
Europe:												
USSR	16.8	39.2	168.0	408.8	16.8	39.2	56.0	67.2	33.6	78.4	224.0	476.0
Poland	16.8	39.2	84.0	140.0	---	5.6	16.8	22.4	16.8	44.8	100.8	162.4
France	---	---	106.4	324.8	22.4	69.2	72.8	72.8	22.4	67.2	179.2	397.6
Spain	11.2	22.4	117.6	308.0	---	---	---	---	11.2	22.4	117.6	308.0
Italy	5.6	11.2	84.0	229.6	---	5.6	5.6	5.6	5.6	16.8	89.6	235.2
Germany	---	---	39.2	106.4	5.6	11.2	16.8	22.4	5.6	11.2	56.0	128.8
Finland	5.6	11.2	16.8	22.4	---	---	---	---	5.6	11.2	16.8	22.4
Other	11.2	22.4	179.2	509.6	5.6	16.8	33.6	39.2	16.8	39.2	212.8	548.8
Total	67.2	145.6	795.2	2,049.6	50.4	145.6	201.6	229.6	117.6	291.2	996.8	2,279.2
Africa	5.6	11.2	156.8	448.0	11.2	22.4	33.6	33.6	16.8	33.6	190.4	481.6
Asia:												
People's Republic of China	5.6	11.2	84.0	224.0	33.6	50.4	61.6	67.2	39.2	61.6	145.6	291.2
Japan	11.2	22.4	61.6	145.6	33.6	56.0	72.8	89.6	44.8	78.4	134.4	235.2
Near East	5.6	11.2	95.2	257.6	515.2	761.6	856.8	862.4	520.8	772.8	952.0	1,120.0
Other	---	---	78.4	229.6	33.6	56.0	67.2	72.8	33.6	56.0	145.6	302.4
Total	22.4	44.8	319.2	856.8	616.0	924.0	1,058.4	10,92.0	638.4	968.8	1,377.6	1,948.8
Oceania	---	---	56.0	173.6	5.6	16.8	22.4	28.0	5.6	16.8	78.4	201.6
World total	168.0	436.8	2,850.4	7,543.2	1,176.0	2,167.2	2,928.8	3,001.6	1,344.0	2604.0	5,779.2	10,544.8

1/ Includes Frasch, pyrites, native ores, and gypsum.
2/ Includes petroleum, natural gas, and nonferrous smelters.
3/ Average 1972 price of elemental sulfur (Frasch and recovered) was $15.21 per short ton f.o.b. mine/plant.
SOURCE: Bureau of Mines.

Table 31--Sulfur production and capacity, world, by regions and countries, 1972

Country	Capacity	Production
	Thousand short tons	
North America:		
United States	13,440	11,420
Canada	8,960	8,348
Mexico	1,680	1,176
Other	336	112
Total	24,416	21,056
South America	672	336
Europe:		
USSR	8,960	7,616
Poland	4,144	3,808
France	2,688	2,464
Spain	1,680	1,232
Italy	1,344	896
West Germany	1,344	896
Finland	896	784
Other	3,360	2,240
Total	24,416	19,936
Africa	1,344	672
Asia:		
People's Rep. of China	2,016	1,344
Japan	4,032	3,360
Near East	1,232	896
Other	336	224
Total	7,616	5,824
Oceania	448	336
World total	58,912	48.160

Source: Bureau of Mines.

Table 32--Sulfur production capacity, world, by regions and countries, 1972-75

Country	1972	1973	1974 1/	1975 1/
	Million short tons			
North America:				
United States	13.4	14.2	15.0	15.8
Canada	9.0	9.5	10.1	10.6
Mexico	1.7	1.7	1.8	1.8
Other	.3	.4	.6	.7
Total	24.4	25.9	27.4	28.9
South America	.7	.9	1.0	1.1
Europe:				
USSR	9.0	9.5	10.1	10.6
Poland	4.1	4.5	4.7	4.9
France	2.7	2.8	3.0	3.1
Spain	1.7	1.7	1.7	1.7
Italy	1.3	1.3	1.5	1.6
West Germany	1.3	1.5	1.6	1.7
Finland	.9	1.0	1.0	1.1
Other	3.4	3.4	3.5	3.5
Total	24.4	25.6	27.0	28.2
Africa	1.3	1.5	1.6	1.7
Asia:				
People's Rep. of China	2.0	2.2	2.5	2.7
Japan	4.0	4.5	4.8	5.2
Near East	1.2	1.6	2.0	2.5
Other	.3	.3	.4	.4
Total	7.6	8.6	9.7	10.8
Oceania	.4	.4	.4	.4
World total	58.9	62.9	67.2	71.1

1/ Estimated.
Source: Bureau of Mines.

Potassium

Reserves

The domestic reserves of potassium, based on 80-percent recovery, total 295 million short tons--about 75 percent in bedded deposits and 25 percent in brines. The bedded deposits are located in the Paradox Basin in southeastern Utah and southwestern Colorado (166 million tons), and in the Permian Basin in the Carlsbad, New Mexico, area (56 million tons). The recoverable potassium resources in brines, totaling 73 million tons, are located in the Great Salt Lake, Utah (59 million tons), and at Searles Lake, California (14 million tons).

An assessment of the potassium resources in the United States and the rest of the world recoverable at various price levels is shown in table 33. The figure for the USSR is uncertain.

Technology

Approximately 95 percent of the world output of potash comes from underground mines.

Various types of mining equipment are used in mines in New Mexico. The ore may be broken by using continuous borers or by undercutting and drilling and blasting. Generally, mechanized loaders are used to load broken ore into battery-driven rubber-tired tram cars which haul the ore to belt conveyors or to rail centers for transportation to the shaft. There the ore is crushed, loaded into skips, and hoisted to surface for treatment.

In New Mexico the first-run extraction of room-and-pillar mining is about 65 percent, compared with 35 percent for the deep Canadian mines. However, in New Mexico, about 55 percent of the remaining potash can be recovered by robbing pillars on the second pass for a total extraction of about 83 percent, whereas pillar robbing is not practical in Canadian mines because of water hazards. At Moab, Utah, underground mining of the deposit was found to be too expensive and, as a result, the operation was converted to solution mining.

The Canadian mines are very highly mechanized. They use crawler mounted borers capable of mining 350 tons of ore per hour, crawler-type loaders rated at 15 tons per minute and rubber-tired tram cars which quickly haul the ore to a belt conveyor rated at 600 tons per hour for transportation to the shaft.

Saskatchewan has a successful solution mining operation. In this operation water is pumped through drill holes extending 5,000 feet to the potash bed. The water dissolves the salts of both sodium and potassium and the brine is subsequently withdrawn through other drill holes or wells to the surface. The process requires strict control and procedures, some of which are guarded secrets.

Table 33--Assessment of potassium resources (principally sylvite) recoverable at various prices, world, by regions and countries

Country	Price, constant 1972 dollars per short ton		
	1/ $48	$55	$60
	Million short tons K		
North America:			
United States	99	295	295
Canada	10,000	21,300	21,300
Other	1	5	5
Total	10,100	21,600	21,600
South America:			
Chile	10	20	30
Other	20	40	60
Total	30	60	90
Europe:			
France	50	200	200
East Germany	2,550	6,640	6,640
West Germany	2,500	6,320	6,320
Italy	30	50	80
Spain	50	200	200
USSR	5,000	10,000	13,200
United Kingdom	50	100	200
Other	70	190	260
Total	10,300	23,700	27,100
Asia:			
Israel & Jordan	235	1,270	1,290
Other	5	10	10
Total	240	1,280	1,300
Africa:			
Congo (Brazzaville)	20	50	100
Oceania:	10	10	10
World total	20,700	46,700	50,200

1/ 1972 average value for U.S. production and U.S. imports of muriate from Canada.
2/ World production in 1972 was 18 million short tons.
Source: Bureau of Mines.

Flotation and fractional crystallization methods are used in Carlsbad and Canada to recover sylvite from the ore. In general, the ore is mixed with a brine saturated with sodium and potassium chlorides and deslimed to remove most of the clay impurities. The pulp is conditioned with an amine flotation reagent and sent to flotation cells where the sylvite is separated from the halite, the principal impurity. The halite fraction is repulped and pumped to tailings, and the sylvite concentrate is dried, sized, and shipped or sent to storage.

Fractional crystallization is based on the solubility-temperature relationship of sodium chloride and potassium chloride in saturated solutions. Crushed ore is mixed with the hot, saturated sodium chloride brine, which selectively dissolves the potassium chloride. The brine is then cooled, and the potassium chloride crystallizes as a 99-percent-pure product.

The producing industry is, for the time being, overexpanded. The development of new sources in Canada together with expanded capacity in other potash areas of the world spells a world surplus at least through 1976. The result is increased competition effecting a lowering in price, expansion of normal consumption rates because of the price situation, and a shifting of supply patterns to the benefit of the richer and lower cost areas. Domestic mines, which have already lost much of the domestic market to Canadian sources, stand to have their percentage of the domestic market even further reduced. Most of the companies producing potash in New Mexico have foreign and domestic holdings and can be expected to operate where the profit margin is most favorable. Most of the domestic production comes from New Mexico and the decrease in domestic output is increasingly felt in that locality. This situation is a sociological rather than a supply problem.

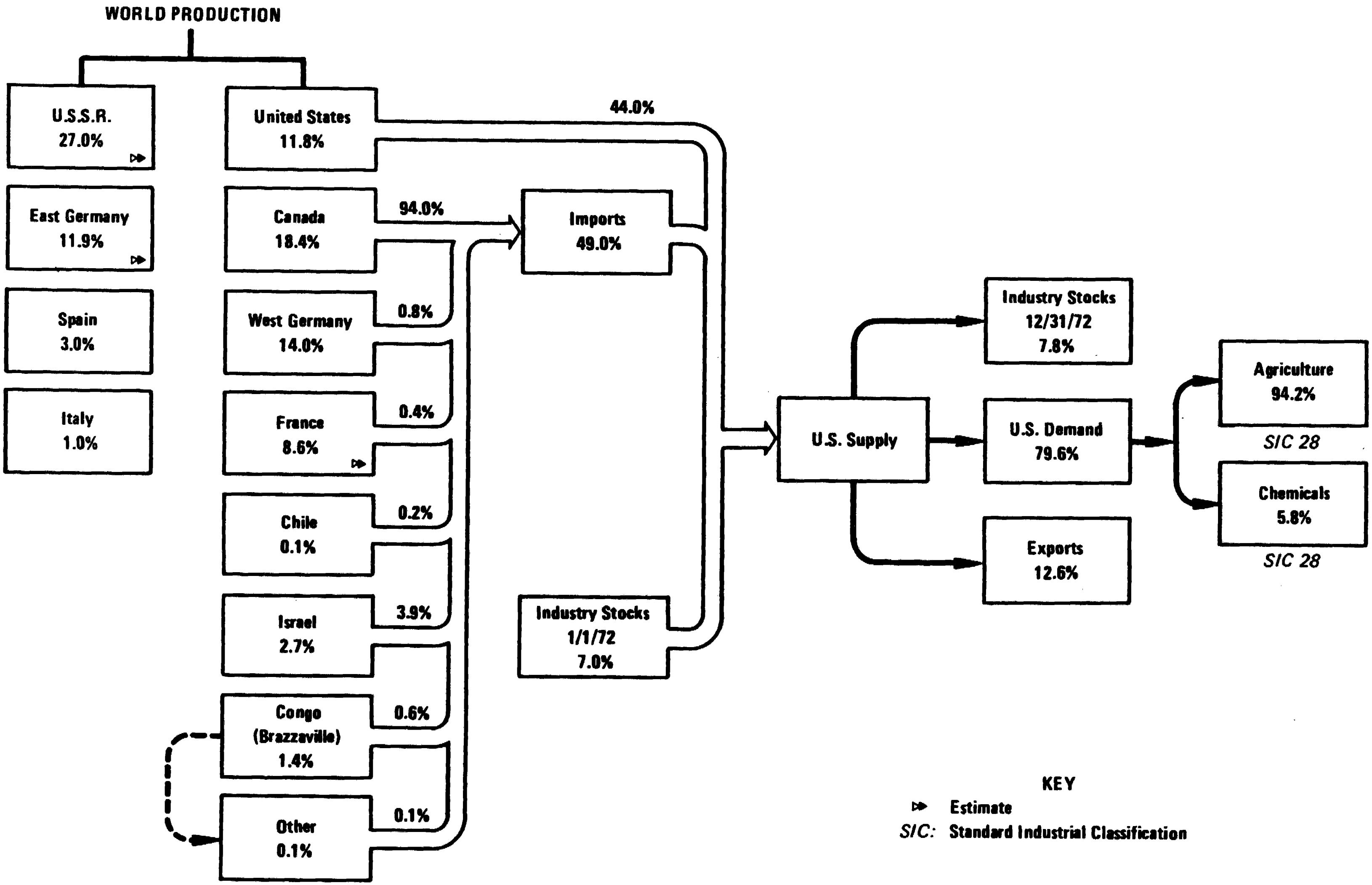
The developed commercial grades of ore in the bedded-type deposits of New Mexico will be depleted in less than 20 years. Although the potential for new discoveries in this region is not promising, relatively large quantities of low-grade ore are available that could become significant if new, more economical mining and refining technology were developed.

Products

Of the 4.0 million tons of potassium used in the United States in 1972, approximately 94 percent was used in agricultural chemicals--usually in mixed fertilizers (fig. 8). The remaining 6 percent was consumed by the industrial chemical industry in the manufacture of a myriad of items.

Figure 8

Potassium supply and demand relationship, 1972



Source: Bureau of Mines.

POLICY ISSUES

U.S.--Short Run

Several alternatives are available for easing the domestic fertilizer situation in the short run: (1) modify energy allocation, (2) embargo exports, (3) allocate fertilizer, (4) encourage imports, (5) establish an information network for identifying surplus and deficit regions, and (6) provide fertilizer high priority use of transportation facilities.

Modified Energy Allocation

Substantial quantities of natural gas are required to produce anhydrous ammonia, the basic nitrogen fertilizer. While about 75 percent of the gas contracts held by ammonia producers gives them a high priority, the other one-fourth have a lower priority which, in periods of peak natural gas use, subjects them to curtailments. Last year natural gas curtailments reduced nitrogen production by an estimated 350,000 tons. Although fewer curtailments have been reported this year, establishing all ammonia production as a top priority use could eliminate natural gas curtailments and ammonia plants could operate nearer capacity.

Shortages of electricity in Florida have reportedly contrained phosphate production in that State. If phosphate producers were established as high priority users of electricity, a steady and sufficient flow of electricity would increase utilization of existing plant capacity.

Export Embargoes

With nitrogen exports utilizing 14 percent of domestic production and phosphate exports utilizing 25 percent, export curbs could increase the domestic supply of fertilizer enough to meet the quantity demanded by U.S. farmers. However, foreign reaction to such a policy may prove costly. If Canada retaliated, for example, the United States could lose over half of its potash supply. In addition, nitrogen imports totaled over 10 percent of consumption in the United States in 1973. An embargo would also have a negative impact on the balance of payments and weaken our free trade arguments in trade negotiations.

Fertilizer Allocation

The net domestic supply of nitrogen is expected to be up nearly 8 percent and potash up 22 percent. Thus, farmers should be able to obtain at least as much of these two nutrients as they consumed last year. However, numerous farmers are reporting substantial shortages, implying that fertilizer distributed to some areas must be greater than to others. Allocating fertilizer could reduce the spot shortages and improve the distribution of fertilizer to farmers. An allocation program should distribute fertilizer to farmers on the basis of its productivity on each farm if maximum return from fertilizer is to be realized. Such a program would be administratively complex. A program that allocated fertilizer on the basis of previous use or crop acreages would be considerably simpler. But it may well reduce yields below what would be realized with current market distribution.

Import Subsidy

Efforts to increase imports may increase the net domestic supply of fertilizer, if supplies can be found on world markets. However, increasing imports may require subsidizing imports as some European countries are reportedly prepared to do.

Information Network

The development of a current fertilizer market information system to quickly identify shortage and surplus areas would complement the normal distribution system and provide a basis for a more equitable distribution of fertilizers if allocation became necessary.

Transportation Support

Many of the problems of fertilizer distribution can be attributed to transportation problems. As spring nears and fertilizer shortage and surplus areas are identified, having transportation equipment available to move fertilizer to the deficit areas would help resolve problems. A program to achieve this would need to address use of cars owned by railroads and industrial firms, as the latter own a major portion of the cars involved.

U.S.--Long Run

Efforts to increase the supply of fertilizer in the long run should concentrate on efforts to increase the availability of raw materials and other inputs. This not only encourages the addition of production capacity, but also fosters fuller use of that capacity.

Hydrogen Supply

The primary factor restricting expansion of nitrogen capacity in the United States is the natural gas shortage, or perhaps more specifically, the shortage of an economical and dependable hydrogen source. Without long-term commitments for natural gas supplies, firms cannot risk investing in production facilities. If the use of natural gas in the production of ammonia was established as a long-term top priority, this risk would be greatly reduced.

Other hydrogen sources can be used in addition to natural gas. Petroleum products are used throughout much of Europe. Because of our petroleum situation, this would be a poor alternative. The United States has abundant coal reserves, but it is currently expensive to recover the hydrogen from coal. If improved technology for handling, processing, and converting coal to other energy forms can reduce its cost and improve its usability, it may provide an efficient substitute for natural gas. Additional research funds for this purpose are warranted. Hydrogen can also be obtained from water, but a large quantity of electricity is required. Research could well lead to improvements in the process that would reduce electricity requirements. Research on hydrogen sources for fertilizer has implications for other industries and should be coordinated with their research.

The alternative to increasing our domestic production of nitrogen is to become increasingly dependent on imports, primarily from neighboring or nearby countries which are currently increasing capacity.

Phosphate Rock

The environmental impact of strip mining phosphate rock is currently limiting expansion efforts. The development of acceptable and economic methods of repairing damage would encourage local governing bodies of Florida to issue mining permits and to rezone lands. Regulations and technology should also be developed to prevent future contamination of fresh water supplies, for example in Savannah, Georgia.

Improving Efficiency of Fertilizer

In addition to increasing the supply of fertilizer, it is necessary to make more efficient use of the fertilizer produced. Efficiency can be improved through: (1) development of economical time-released nitrogen fertilizers; (2) development of nitrogen fertilizers less subject to volatilization: (3) more nearly optimal timing and rate of application; (4) improved water management, whether from rainfall or irrigation, to control leaching and nutrient erosion: (5) more adequate soil testing to avoid overfertilization and imbalance between nutrients. Continued support of research and extension efforts with emphasis in these areas may facilitate improved efficiency in fertilizer use.

World Situation

Opportunities are limited, beyond domestic improvements, for improving the world situation through policy action. First, the United States should strongly urge governments of LDC's to more actively support their fertilizer programs. If plant operating rates could be raised above their current low levels, the current situation would be alleviated. In addition, a world information system that continuously monitors and reports production and consumption information and maintains timely data on capacity and announcements to change capacity should be established. This service would be invaluable to fertilizer manufacturers in long-range planning. Consequently, the sporadic investment in production facilities which has contributed to the world problem could likely be replaced with more uniform expansion. The United States should strongly support Foreign Agriculture Organization's Commission on Fertilizer currently being organized, particularly regarding the above issues.